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Practical Perspective;

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Perspective made easie.

Teaching

By the *Opticks*, How to Delineate all Bodies, Buildings, or Landskips, &c.

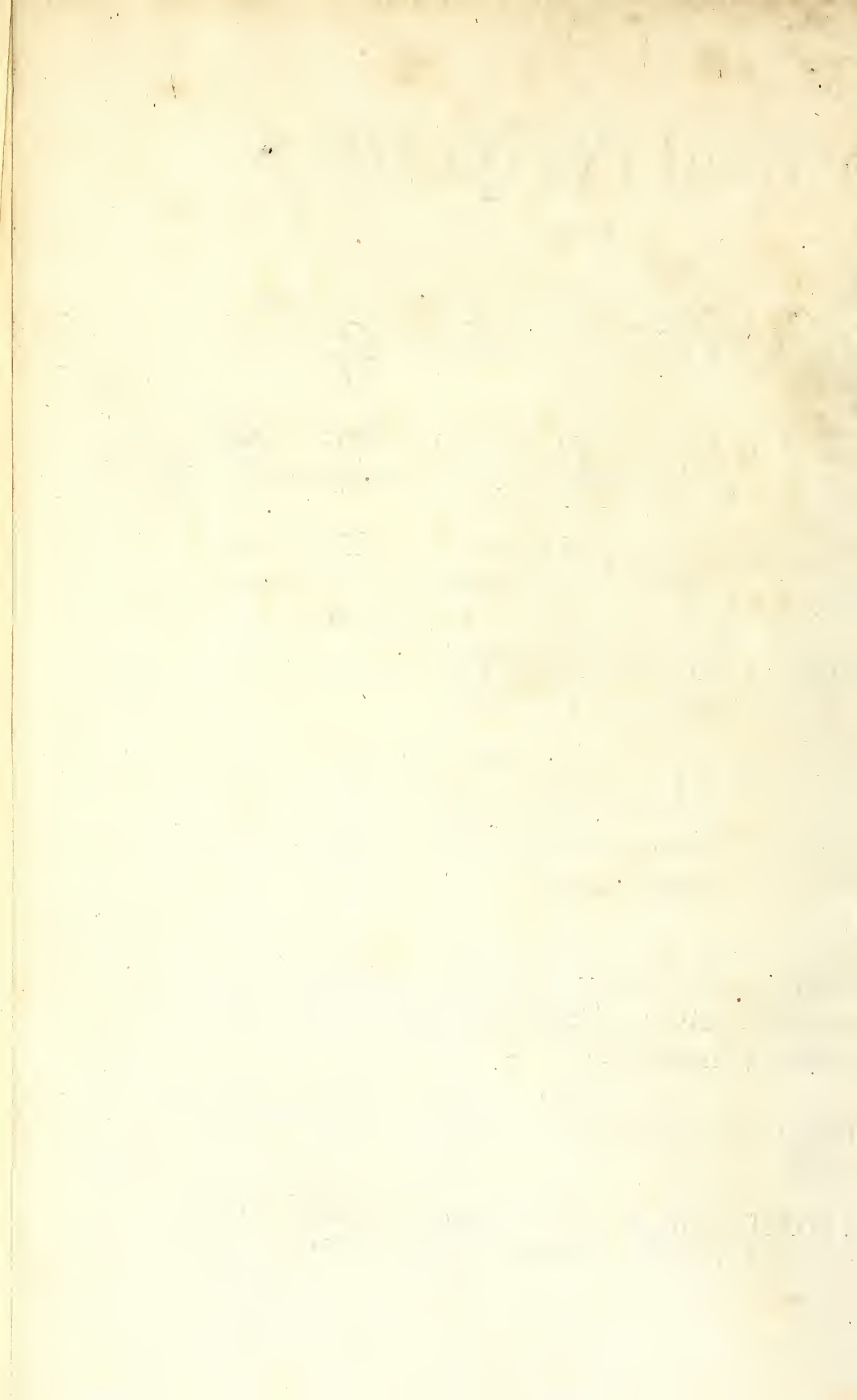
By the *Catoptricks*, How to Delineate confused Apperences, so as when seen in a Mirror or Polliht Body of any intended shape, the reflection shall shew a Designe.

By the *Dioptricks*, How to draw parts of many Figures into one, when seen through a Glasse or Chrystal cut into many Faces.

Usefull for all *Painters, Engravers Architects, &c.*
and all others that are any waies inclined to Speculatory Ingenuity.

By Joseph Moxon *Hydrographer to the Kings most Excellent Majesty.*

LONDON. Printed by Joseph Moxon, and sold at his shop in *Russel street*, at the Signe of *Atlas*. 1670.



To the Worshipfull
WILLIAM ROPER Esq.

Sir,

I Present you with this peece of Practical Perspective: Not that I think you unskilfull in this Science, for I know your affections to Mathematical Arts are great, and your perfections therein greater than to learn any thing from me. But as you are a general encourager of ingenuous Studies, and have exprest a particular respect to me by your many Civilities, I alwaies reckoned my self bound to an humble acknowledgement; which Sir, if you will accept this as a token of, it will yet more oblige me to be

Sir,

Your most humble servant.

Joseph Moxon.

1. The first part of the book is devoted to a general survey of the history of the world from the beginning of time to the present day.

The second part of the book is devoted to a detailed account of the history of the United States from the first settlement of the country to the present day. This part of the book is divided into two volumes, the first of which covers the period from 1776 to 1865, and the second of which covers the period from 1865 to the present day.

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To the Reader.

AMong the ingenuous Sciences practised in this Nation Perspective ought not in right to have the least esteem; For that it is full of most ravishing Speculations I think none that knows what it is will deny. But that it is most absolutely necessary for all Painters, Engravers, Architects and others that have occasion to draw Drafts &c. all must confess: For indeed without it the Painter can neither paint Landskips, Houses or other Figures proportionable and true, or the Architect designe any more than an Orthographick Structure on his Ground-plot. But on the contrary, If an Artist works by the Rules of Perspective, he may paint a remote peece with many Figures in it, and give every Figure its true place and size, and so shadow his work that shall seem more like the thing it represents than a representation of the thing: And the Architect may draw on his Ground plot the appearance of several sides of his Building, and place on them either doors, windows, Balconies, &c. each in its proper shape and scituation.

Since therefore it is both necessary and delightfull, I have for the accomodation of English Artists taken the pains to write this following discourse of Practical Perspective: And I was the rather induced hereunto, because as yet nothing of this nature hath been published in English except Sebastian Serlio, who though he where a man of skill and fame, yet his book being originally written in Italian, was first translated into Dutch, and afterwards from Dutch into English: One of which translators (if not both) doubtless understood the language better than the Art; for therein (as the generallity of Ingenuous Artists do with me confess) the words are translated, but not the Science.

In this work to save my self the trouble of making all new designes I have collected from several Authors such Figures as I found most usefull for the Instructions of a

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learner,

To the Reader.

learner, as from Albert Durer, Neceron, Jean Cofin, Defargues, but the generallity from Hondius, who had them as himself saies (and you may see) from Marolois.

Such hath been my care in writing these Instructions, that I dare promise thee they are all true: Such my curiosity in chusing the Terms that some good Authors, and able Artists as well as my self have thought them most significant. And such my desire that thou shouldst learn by this Book, that all along in it I have observed my wonted plainness, so that by it (as I say in the Title) is Perspective made easie.

Farewell.

Joseph Moxon.

CHAPTER. I.

Containing the Definition of Perspective, and its Species.

OPTICK in Greek is PERSPECTIVE in Latin; and both words (according to Grammarians) signifie in English *Seeing, or Sight.*

But the *Opticks, or Perspective*, (which as you see is all one) hath yet a more sublime signification than barely *Seeing, or Sight*, (that being common to all sensitive Creatures,) For

DEFINITION I.

Perspective is a Mathematical Science, that Speculates, and Contemplates, the manner and properties of all Radiations, Direct, Reflected, and Broken.

DEFINITION II.

By Direct Radiations is meant that branch of Perspective or Opticks, wherein is considered the Direct or Straight beam that passes between the Ey and the Object. This Specie of Perspective is many times (alone) called the Opticks.

DEFINITION III.

By *Reflect Radiations*. Is meant the Art *Catoptrick*, wherein is considered the Reflection of Beams, and their shape, upon any Polisht Body; as a Globe, a Cone, a Cilinder, a Piramid. &c.

DEFINITION III.

By *Broken Radiations*. Is meant the Art *Diop-trick*, wherein is considered the breaking of beams as they be seen through a Glass or Christal cut into several Plains, or Faces.

This Art or Science is by curious wits brought into *Theory* and *Præctice*. The Theory is defined as aforesaid. And

DEFINITION V.

The Practice I may define to be an Art Manual, whereby the Theory is reduced to Act. This Manual Art is compounded of *Ichnographie*, *Orthographie*, and *Scenographie*.

DEFINITION VI.

Ichnographie is the Base or Bottom whereon any Body or Building is erected. And therefore the Office of *Ichnographie* is to describe the Bottom or Base of any Body, or Building.

There be two sorts of *Ichnographies* named in this Book, viz. the *Geometrick Ichnographie*, and the *Scenographick Ichnographie*.

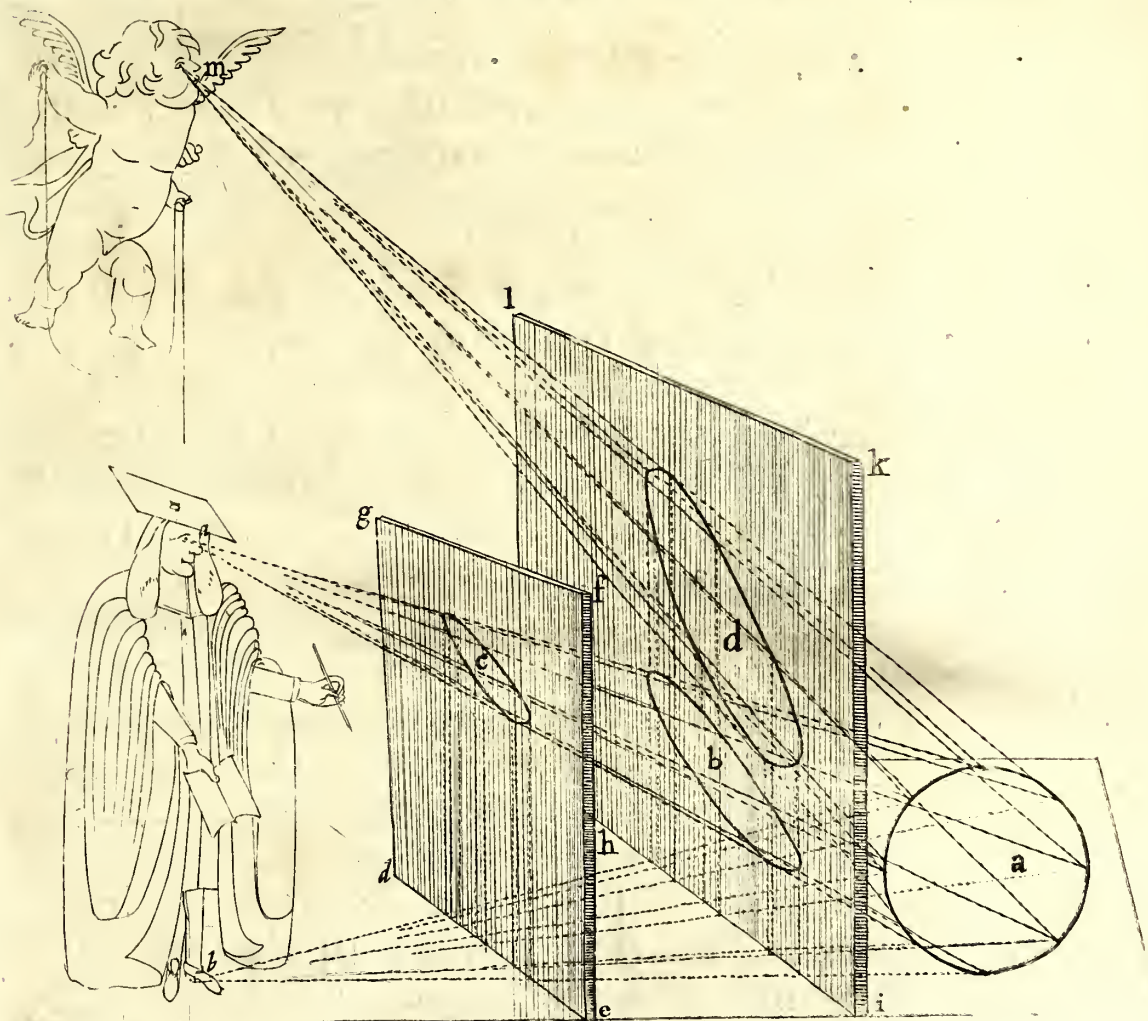
DEFINITION VII.

By the *Geometrick Ichnographie* is meant the true Geometrick Bottom or Base of any Body or Building; as a Circle is the Base of a Column, and a Square of four equal sides is the Base of a Pedestal &c. This Geometrick *Ichnographie* is not seen in Section, or through a Glass, unless it be a Glass that lies parallel to the Base, and therefore makes no Section with it. But

DEFINIT.

DEFINITION VIII.

The *Scenographick Ichnographie* is the appearance of the same Base in Section, or through a Glass erected perpendicularly on the Plain whereon it stands: As allowing the Circle *a* to be the Geometrick Ichnographie of a Column, the Scenographick Circles *b c d* shall be the Shortned Ichnographies of the same Column.



DEFINITION IX.

The *Orthographie* of any Body or Building, is the fore-right side of any Plain. That is, The side

side or Plain that lies parallel to a straight line that may be imagined to pass through the outward convex points of your two Eys, continued to a convenient length. As the Plain of the Cube in *Oper. XIX.* marked L is the Orthographick Plain of that Cube. Therefore the Office of Orthographie is to Delineate the fore-right Plain.

D E F I N I T I O N X.

The *Scenographick* Appearance of any Figure, Body, or Building, is that side that declines from, or makes angles with that straight line imagined to pass through the two outward convex points of your two Eys aforesaid. Workmen generally call it the *Return* of a fore-right side. As the Plains M and N of the same Cube in *Oper. XIX.* are the *Scenographick* Plains or sides of that Cube. Therefore the Office of *Scenographie* is to describe a Plain, or other Figure that declines from the Orthographick Plain. That is, makes angles with the Plain of the Orthographie.

The knowledge of *Scenographie* comprehends so much of the Art of *Perspective*, that without scruple many Authors call it *Perspective*, when in their works they frequently say the *Perspective* appearance, though they only treat of a *Scenographick* Figure: As if they concluded, that he who arrives to so great a perfection in *Perspective*, as *Scenographie* understands or with difficulty may understand the whole Art of *Perspective*.

The *Scenographick* Appearance differs from the Orthographick in this; The Orthographick represents the side of a Body, or Building, as it is seen when the Plain of the Glass stands parallel
to

to that side. But Scenographic represents the side of a Body, or Building, as it seems through a Glass erected not parallel to that side.

These foregoing Definitions serve to shew you who the Lady Perspective is, and her fair Handmaids *Ichnographie*, *Orthographie*, and *Scenographie*: who all of them in their several capacities dress her so curiously, that he who is ever admitted her presence, shall see a Person beautifull enough to commit a rape upon his Ey. But she has a Language by her self, which is one reason she is no better understood; yet it is very easie to learn, and to make it appear so, I have compos'd this smal Dictionary following,

CHAPTER. II.

Containing Definitions used in this Art.

DEFINITION I.

The *Base*. Is the Plain whereon any Object is placed, which for Example sake we will suppose to be a huge great plain Field, or if you will but the flat Floor or Pavement of some Hall or Chamber. As in *Defin. VI.* of this Chapter, *f g h i* is the Plain: This Plain or Floor we shall all along hereafter in this Book call the *Base*.

DEFINITION II.

The *Height*. Is the Perpendicular distance between the Base and the Ey, or which is all one The Height of the Visual point above the Base, because the Ey lies alwaies in the Horizontal line, as well as the Visual point. Thus the height from

a to *b* in the aforesaid Figure is called the *Height* of the Ey.

DEFINITION III.

The *Visual Point*. This point is not that point the Ey is placed in, (as most young Students in this Art are apt to think:) But is a point in the Horizontal line wherein all the Occular raies unite. For Example, If you look on a long straight Brick wall, you will perceive the several laies of Mortar between the several courses of Bricks seem to incline towards each other, as if they ran into one common Center: Or as if you were in a long straight Gallerey where the two Sides, the Floor, and Ceiling, seem to incline and touch each other in a point or common Center, which point reflected on a Glass erected perpendicularly on the Base, is called the Visual point. This you may experiment if you lay the Muscovie Glass in *Definition* VI. flat upon the Object *a b c d*, for then so much of your Scenographick Figure as is made of Visual raies, as the lines *a b* and *c d*, shall run into a point opposite to the point *e*: which point elevated to the height of the Ey is the Visual point, as aforesaid. This point is by some Authors called also the *Center*: and by others the *Principal Point*.

Note, that where an Object is reflected, it is also reverted, as you may see in Looking Glasses and cleer water. And for this reason it is, that Orthographick Figures are inverted in their Scenographie. As you may see in most of the Figures throughout this Book.

DEFINITION IIII.

The *Horizontal Line*. By the Horizontal line is not

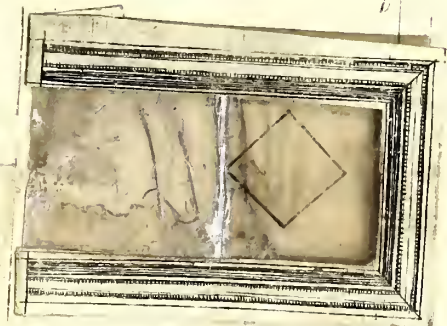
not meant the Base or Line of Earth, though in Astronomy &c. it is generally so taken; But it is a Line proceeding from the Ey, (which in Men of a common size is placed about five foot above the Base or Ground they stand upon,) into the Visual point, and is Parallel to the Base, as the Line *b c* in Chap. 1. *Defin. 8.* is the Horizontal Line.

DEFINITION V.

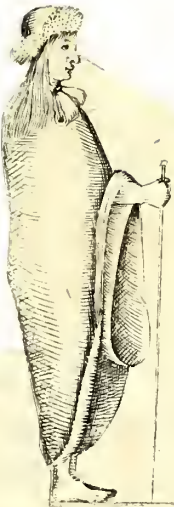
The *Distance*. The Distance is that space on the Base contained between the Glafs and the point in the Base that lies directly under the Ey. As from the point *a* in the Base, to *o* at the Glafs is called the Distance. Note that in many Figures two points of Distance is required, as in *Operation 10, 15, 16, 17, 18,* and several others throughout this Book.

DEFINITION VI.

The *Section* Is a Plain of transparent matter erected Perpendicularly on the plain of the Base, and stands directly before you, that is is Parallel to a straight line imagined to pass through the convex points of your two Eys: As is this Plain of Muscovie Glafs erected before the Fi-



gure



D

figure *e*. This Plain is by some Authors called the *Section*, by others the *Table*, and by others the *Glaß*. They that call it a *Section* call it most properly, Because it cuts or intersects the Plain whereon it stands, as here it cuts the Plain or Base *a b c d*. And they that call it a *Table*, call it so allusively as they do other Planis whereon any thing is either painted or written. But they that call it a *Glaß* have some good reason for it too, Because we know as yet no other matter so apt to demonstrate the changing of an Orthographick Figure into a Scenographick as *Glaß*: And therefore though I confess the word *Section* to be more proper than the word *Glaß*, yet because (as I said before) my design is Practice: I shall all along in this Book (when I have occasion to name this Plain) call it *Glaß* and not *Section*.

This *Glaß* or *Section* is absolutely necessary to be understood by all young Students in the Art of Perspective. Because (as by what hath already been said) without knowing what it is they cannot know what Perspective means: Neither can they know the reason why the Scenographick Figure alters from the Orthographick, or one Scenographick Figure from another. But by rightly understanding this *Glaß* they may easily perceive the Various affections of Scenographick appearences. For first, If the *Glaß* be placed near the Visual point and far from the Object, the Figure appearing therein will be very small: Because all the raies which inclose both Orthographick and Scenographick Figures though wider asunder at the Object run into the Visual point as into a common Center: As you may see in the first Figure, where the Circle *a* appears much smaler in the Plain or *Glaß* *d e f g*, which stands neer the Visual point and farther

farther from the Object than in the Glafs *h i k l*, which stands farther from the Visual point and neerer the Object. Secondly, If the Visual point be placed higher, though at the same distance from the Object the greater the Scenographick form appears: As you may see if you place the Visual point at *m*, and delineate the same Circle Scenographically as *d*, it becomes bigger in length and bredth; for the Visual raies being elevated the several Perpendiculars erected on the Glafs intersect them in wider distances, Because futher from the Glafs. As you may see in the Scenographick Circle *d*. Thirdly, If this Glafs were set oblique to the Plain, the Figure would again alter; For if it Incline to the Visual point the Scenographick appearence of this Circle (for Example,) shall on the Glafs lengthen between the Visual point and the Object: Because the Plain of the Glafs gathers in more of the Visual raies: And if the Glafs Recline from the Visual point the Scenographick appearence shall grow rounder and more like the Orthographick Figure. But if the Glafs be placed parallel to the Plain the Object lies on, the Scenographick and Orthographick Figure shall appear the same; Because the Figure is not seen in Section. And all this you may easily experiment by erecting the Muscovy Glafs in *Defin. VI.* of this Chap. between your Ey and the Figure: For if you keep your Ey steddy in one point, and with a black-lead pencil trace about the edges of the same Figure as you find it on the Glafs, you will have the true Scenographie of that Figure: As you may try by comparing it afterwards with the same Figure drawn by the Rules of Perspective, as they are taught in this Book.

DEFINITION VII.

The *Visual Raies*, or *Diametrals*, are those lines which proceed from the Visual point through a Glasse to any point either above or below the Horizon. As in *Oper. II.* the line *cfe* is a Visual Raie or a Diametral: So is the lines *ckg*, and *clf* in *Oper. III.*

DEFINITION VIII.

Lines of Distance, or *Diagonals*, are those Lines that are drawn from the point of Distance, to any point either above or below the Horizon. As in *Oper. III.* the line *bki*, is a line of Distance: So is the lines *bdh*.

DEFINITION IX.

The *Object*. The Object is that Figure, Body, or Building you intend to describe in Perspective. As in *Oper. II.* the point *d* is the Object: So are the Squares *defg*, and *lmno*, in *Oper. III.*

CHAPTER III.

Several Methodical Rules and Observations, that may facilitate your Practice in Perspective.

1. **A**LL Lines that in the Object or Geometrick Figure are straight lines, are in Scenographie also straight lines.
2. All Lines that in a Geometrick Figure are Perpendiculars, must in Scenographie also be Perpendiculars.
3. All Lines that in a Geometrick Figure are Paral-

Parallel to its Base, must in Scenographie be also Parallel to the Base.

4. All Lines that in Geometrick Figures return at Right Angles from the Orthographick or fore-right side, must in Scenographick Figures be drawn from the Visual point.

5. All Right Lines that in a Geometrick Figure return from the Orthographick or fore-right side, in a Scenographick Figure run into the Horizontal Line. And

6. All Lines that in the Geometrick Figure are Parallel to that return-line, shall in a Scenographick Figure be drawn from that point found in the Horizon.

7. If a Right Angle having one of its sides against the Base be to be cut off, so as the two sides of it shall remain equal: Then a line drawn from the point of Distance shall so cut it off.

8. If the Figure you designe to draw stands on your right hand, you must place it on the right hand of the Visual point. If on your left hand, you must place it on the left hand of the Visual point. But if on neither hand, the Visual point must be placed in the middle of it.

9. If you set off the Height of Columns, Posts, or other things, you must measure the designed Height from the Base-line upwards in the Front or Orthographie, and a Visual raie drawn from that point in the Front shall shew the Height of your Columns, or Posts, all the way behind the Orthographie, even to the Visual point. As in *Oper. XXIX. &c.* This is a Rule in all Figures, as well wherein there is an Orthographick side placed before it, as where there is none.

10. If you are to make Circles, Arches, Crosses, Cross-Arches, or any other Figure in the Roof of any Room, you must first project the same on

the Ichnographie, and so with Perpendiculars from the eminent points of the same, carry it up into the Ceiling: as in *Oper.* 20, 21, 22, 23, 24, 25, 26, 27, &c. And then from those several points carry on your Circle, or Arch &c. As in *Oper.* 9, 10, 11, 12, 13, 25, 26, &c.

11. If you would find the middle point of any Scenographick Square, Cross it in the Diagonal Angles with two lines, and in the point where they cut each other is the middle of the Square. As in *Oper.* 17, 20, 21, 22, 23, 24, 25, 26, 27, &c.

12. A Ground Plain of Squares is the same above the Horizontal line it is below: Only if it be farther distant above or below the Horizon the Squares will be so much the wider. As in *Oper.* 20, 21, 22, 23, 24, 25, 26, 27, &c. and all other wherein Roofs, or Ceilings are described.

These brief Rules will much help you in your Practice.

A Caution or two for your more profitable reading this Book.

YOU must take special notice of the several shapes of Letters wherewith the several points of each Figure is marked; for in some Figures there come so many Letters, that I was forc'd to reiterate them: But then the Letters are made in an other shape; either in Capitals, as A, B, or smal Roman, as a, b: when as otherwise they are set down in Italick Letters, thus, *a, b*. For if you do not take notice that the Letter you seek in the Figure be of the same sort with that you read in the *Operation*, you may easily mistake one part of the Figure for another.

Secondly,

Secondly, The different Letters are sometimes made to shew the correspondent points of the Geometrick and Scenographick Figures; as in *Oper.* VI. the severall points in the Geometrick Hexagon are marked with Italic Letters, thus, *d e f g h i*, but in the Scenographick Hexagon the respondent points are marked with Romain Letters thus *d e f g h i*.

You are sometimes directed in this Book to draw a line from the Point *a b c d*, &c. when the point intended is not in the Plate, but lies out of the Plate in the Horizontal line. As in *Oper.* XXXIII. you are directed to draw a line from the point *c*, but it is thereby meant you should draw a line from that point where *c* should stand, viz. where the line *d 13 c* if continued would cut the Horizontal line, which is the Visual point; and is in that Figure marked *c*.

Take this advice in Drawing a Perspective Figure, wherein there comes many Lines: For I have observed one main thing that makes Perspective be thought so difficult, is the mixture of many Lines directing to many designed points: Therefore when you draw some busie peece in Perspective, you may for the directing your Ey, Draw the Diagonals in Red, the Visual Raies in Black, Perpendiculars in Green, or any other different Coullers from that you intend your Perspective Figure shall be of.

There may be some more Rules worth your Notice: but as yet not coming to my memory, Take these for the present; and as the rest offer themselves to me, I shall present them to you. In the mean time, If you meet with any words of Art you understand not, Look over the Leaf; where I have digested them in an Alphabetical order, and to them annexed their explanation:

An Explanation of such Un-usual words as you may find in this Book.

Arch. A peece of a Circle. As in Oper. 2 *e d* is an Arch of a Circle. *Axis.* is that straight line whereon any Body moves circularly, as in the line *a a* in Operat. 21. is the Axis of the Door.

Base. See Chap. 2 Defn. 1. *Broken beams.* See Chap. 1 Defn. 4.

Capital. The top of a Column. *Catuzes.* *cf* in fig. 22 are Catuzes. *Catoptrick.* See Chap. 1 Defn. 3. *Center.* The middle point of a Circle, or any other figure. *Cilinder.* A straight round Body, flat at either end. Fig. 53.

Column. The upright Pillars markt *x a b y c t* in fig. 30. *Composite Order.* an Order in Architect. See *Vignola*. *Cone.* Fig 54. *Corinthian Order.* An Order in Architect. See *Vignola*. *Cube.* A Square Body of six equal sides, as *I K L* in fig. 19 are Cubes.

Diagonals. See Chap. 2 Defn. 8. *Diagonal Squares.* The squares in fig. 16. are all Diagonal Squares, because all their sides are Diagonal lines. *Diametrial.* See Chap. 2 Defn. 7. *Dioptrick.* See Chap. 1. Defn. 4. *Direct beam.* See Chap. 1. Defn. 2. *Distance.* See Chap. 2 Defn. 5. *Dorick Order.* An Order in Architect. See *Vignola*.

Equilateral Triangle. A Triangle of equal sides, as are the Triangles *d e f* in fig. 5.

Geometrick Figure or Body. is a Figure or Body that hath its true demensions.

Ground line. See Operat. 51. *Ground-plain.* A plain full of Squares as fig. 15. 16.

Height. See Chap. 2 Defn. 2. *Hexagon.* A figure of six equal sides is a Hexagon; as the two figures in fig. 6. are Hexagons. *Horizon.* See Chap. 2. Defn. 4.

Ichnography. See Chap. 1 Defn. 6. *Intersection.* Two lines crossing one another are said to intersect each other. *Ionick Order.* An Order in Architect. See *Vignola*.

Luminious Body. Light body, as in fig. 51. 52. to 56. at *a* is the Luminous body.

Newel. is the upright post a pair of winding stairs winde about.

Object. See Chap. Defn. 9. *Occult.* Occult lines or Arches are dark lines or Arches: which are only drawn for direction to make the Figure up by: these are throughout this book represented by prickd lines and arches. *Octagon.* a Figure of eight equal sides is an Octagon. As are the two Figures in Fig. 8. *Opacous body.* A Dark body As in Fig. 51. 51. 53. 54. 55. 56. the bodies obstructing beams of Light are Opacous bodies. *Optrick.* See Perspective. Chap. 1 Defn. 1. *Orthography.* See Chap. 1 Defn. 9.

Parallel. Parallel lines are straight lines that are all the way equally distant from one another; as the Base and Horizon throughout this book, are all parallel to one another. *Parallelepipedon.* is a square body that hath its four sides longer than its two ends, As in fig. 56. the square body *f g*. *Pedestal.* A square body whereon a Column is set, as *d* in fig. 28. *Pentagon.* A Figure of five equal sides, as are the two figures in fig. 7. *Perpendicular.* A line that falls plumb upon another line, without leaning to one side or another is a Perpendicular line. *Perspective.* See Chap. 2 Defn. 1. *Pilasters.* Square Pillars that usually stand behind Columns to bear Arches &c.

Quadrat. A square figure of four equal sides. *Quadrant.* A figure containing the fourth part of a Circle.

Radius. Half the Diameter of a Circle. *Reflected beams.* See Chap. 1 Defn. 3. *Right Angle.* is made by two lines exactly Perpendicular to one another.

Scenography. See Chap. 1 Defn. 10. *Section.* See Chap. 2 Defn. 6. *Semi-circle.* Half a Circle. *Station.* The place you stand on.

Tetrahedron. is a Body whose four Plains are four Triangles, as in fig. 55. *Tube.* a long hollow instrument wherein is usually a Glas fitted, to observe objects through. *Tuscan Order.* An Order in Architect. See *Vignola*.

Visual point. See Chap. 2 Defn. 3. *Visual raies.* See Chap. 2 Defn. 7.

OPERAT.

OPERATION. I.

Height and Distance given, To find the scituation first of a Point, secondly of a Line, and thirdly of a Square, in the Glasse or Section.

THe given Height from the ground to the Ey. or which is all one from the Base to the Horizon is ab , the Distance from the Foot to the Glasse is ac . The given point or Object to be represented in the Glas or Section is d . The Glas erected perpendicularly on the Base is $efgh$. Draw a Visual ray from the Ey at the point b to the Object at the point d , as bd , and another line from the point of Station a to the same point d , as ad ; then erect a Perpendicular on the point where this line ad cuts the line of Section as at c , and where this Perpendicular cuts the Visual ray bd as here it does in i is the point that the Object d appears in the Glas.

To find the Scituation of a Line in the Section or Glas, You must have the Height given, as ab , and the Distance as ac , And as you were taught before to find the place of one point in the Glas, so now by the same Rule the Operation must be doubled to find the place of two points in the Glas, and then a straight line drawn between those two points is the line required. *Example.*

The given Line is de , Therefore from the Visual point b I draw two straight lines or Visual rays to the two points at the two ends of the line de , and two other straight lines from the point of Station a to the same points $d e$, And from the points where these two lines intersect the Glas (as here they do in the points cf) I erect Perpendiculars into the two Visual raies, and where these Perpendiculars intersect the two Visual raies (as here they do at gb) is the points de represented in the Glas, and a straight line drawn between the points g and h represents in the Glas the straight line de .

To find the scituation of a Square figure in the Glas. You have the given Height ab , the Distance c . Draw Visual rays from the Visual point b to every angle of the Square $defg$, and draw also lines from the point of Station a to every angle of the Square: and where these lines of Station cut the line of Section (as here they do in the points $hikl$) erect Perpendiculars into each respective Visual ray, and where these Perpendiculars cut each respective Visual ray (as here in the points $mno p$) shall be each respective point of the Square in the Glas. and straight lines drawn from point to point shall include the Square.

These three Operations (though in effect but one) are sufficient

to shew the nature and quality of the Appearance in Section or Glasse : but this way is not much used among Artists; nor is it so ready for use as laying the Figure along on the Base-line drawn Parallel to the Horizon; because this way you must draw several Base-lines, even so many as you have given points in your Figure; for in this Square you have four Base-lines, as the lines $d a, e a, f a, g a$, are all Base-lines, which together with the line of Section and the several Perpendiculars erected on them would so pester a large Designe that it would be both tedious to draw and difficult to understand when drawn: Therefore I shall hereafter in the rest of this Book leave out the Glasse thus erected, and shew you how to perform the same by laying the Figure along on the Base.

OPERATION II.

Height and Distance given, to find the true Scenographick place of a given Point.

THe given Height is $a b$, the Distance given is $b c$, The Point given is d . To set this Point in its true Scenographick place, Draw a line to represent the Base, and at the given Height $a b$ above it draw a line parallel to the Base, to represent the Horizon, as $c b$; Then draw a Perpendicular to the Base $a a$ and Horizon as $b c$ into a as the line $b a$, and placing one foot of your Compasses on the point a open the other to the point d , and describe the prick arch $d e$; then lay a straight Ruler to the point of Distance b and to e , and by the side of it draw the line $c e$ (which we shall call a Diagonal line) and where this Diagonal line cuts the Perpendicular $b d a$ (as here it does in f) is the Scenographick place of the point d .

OPERATION III.

Height and Distance given to describe the Scenographick appearance of a Line.

THe given Height is $a b$, the given Distance is $c b$, the given Line to be delineated in Scenographie is $d e$. Therefore from the given points $d e$ let fall Perpendiculars into the Base, as $d f$ and $e g$, and placing one point of your Compasses in f open the other to d , and set off that distance on the Base, as at h , then place one foot of your Compasses in g and the other to e , and set off that distance also on the Base, as at i ; then to the perpendicular points f and g draw the Diametrals as $c f$ and $c g$, and from the transferred Distances h and i draw Diagonals as $b h$ and $b i$, and where the Diagonals intersect the Diametrals (as here in k

in k and l shall be two points, between which the straight line kl being drawn shall be the Scenographick appearance of the line de .

If you understand these two Operations rightly; you have already made a good progress in Perspective; for knowing how to place every point and line, you must needs know how to draw all Lines Figures and Bodies: Lines being but a progression of points. And all Figures are made of Lines, and all Bodies made of Figures, according to the Definition of Geometers.

Having shewed you how to draw a Point and a Line: I come next to Figures, for the drawing of which Scenographically, I shall give you this general method, which after (by a little practice) you have made your self familiar with, will serve you to draw all manner of Figures.

Having considered your Height and Distance, and in what Position your Figure shall stand, and drawn it accordingly, either with its Side or Angle against the Base: Erect Perpendiculars from the several Angles, or other designed points in your Figure into the Base, and transfer the length of each Perpendicular from the point where it touches the Base, to the Base on the side contrary to the Point of Distance: For then Diametrals drawn to the Perpendiculars in the Base, and Diagonals to the several transferred distances shall at the intersection with their respective Diametrals give the Angles of the Figure. That is, where any Diagonal drawn from any transferred distance on the Base, shall intersect the Diagonal drawn from the Perpendicular on the Base of that transferred distance, shall be the point where the Angle shall be placed, that represents in Scenographie the Angle from whence the Perpendicular was erected on the Geometrick Figure: and lines drawn from point to point, shall inclose the Scenographick Figure.

This is a sure method and plain; yet because I will make it more easie, I shall give you several Examples of this way of working in several Figures; viz. the Square, a Triangle, a Hexagon, a Pentagon, an Octagon, a Circle, an Oval, and an irregular Figure in several Positions.

OPERATION IIII.

Height and Distance given to describe the Scenographick appearance of a Quadrat, or Square, in two Positions; one with its Side against the Base, and the other with an Angle against the Base.

THe given height is ab , and the distance cb . First draw the Base, and Parallel to it at the given height ab , draw the Horizontal line: under the Base erect a square Figure, with one

of its sides against the Base, as $d e f g$ and transfer the distance of the angles from the Base into the Base, by placing one foot of your Compasses in the angles of the square, at the Base as at e , and extend the other to the point f , and transfer this perpendicular distance of the point f into the Base as at b : then remove your Compasses to the point d , placing one foot there, and extend the other to the point perpendicularly under it, as to g , and transfer that distance also into the Base, as at e : Then draw Diametrals from the point c to the perpendiculars $e f$ and $d g$ in the Base, and Diagonals from the transferred distances $f b$ and $g e$, and where these Diagonals intersect the Diametrals, as here in $i k$, shall be two angles of the Square, and a line drawn from k to i shall be one side of the Square, and so much of the Diametral as is comprehended between $k e$ is another side of the square: also so much of the Diametral as is contained between $i d$ is another side of the square: and the other side of the square lies in the Base, as you may see by the line $d e$.

Here is also laid down a Geometrick Square of four equal sides, having its angle l placed against the Base. To describe this in Scenographie, draw lines from the angles $m n o$ Perpendicularly up to the Base, as at the points $p q$, and upon these points measure the distance of the angles $m n o$ from the Base, and transfer those distances into the Base, as the distance of $p m$ falls on l , the distance of $l n$ falls on r , and the distance of $o q$ falls at r , for Diametrals drawn from the Perpendiculars in the Base, and Diagonals from the transferred distances in the Base, shall intersect each other in the points $s t v l$, which are the four angles of the Scenographick Square: and straight lines drawn from t to v , from v to l , from l to s , and from s to t , shall include the Square. Where the Diagonal $b r$ intersects the Diametral $c q$, is the angle v , and a line drawn from l to v shall represent the side $l o$; where the Diagonal $b r$ intersects the Diametral $c l$, is the angle t , and a line drawn from v to t represents the side $o n$: and where the Diagonal $b l$ intersects the Diametral $c p$ is the angle s , and a line drawn from t to s represents the side $m n$: And lastly a line drawn from s to l represents the side $m l$, and incloses the Scenographick Square, according to the former height and distance given.

OPERATION V.

Height and Distance given, to describe in Scenographic the Appearance of two Equilateral Triangles: One with one of its Angles against the Base, and the other with one of its Sides against the Base.

DRAW the Base aa , and Parallel to it the Horizontal line bb , at the given Height ab : place your Visual point in this line as at c , then draw your Triangle (as def) under the Base with one of its Angles (as d) against it, and from the other two Angles erect Perpendiculars up to the Base, as eg and fh , and transfer the distance of those Perpendiculars from the Base to the Base, by placing one foot of your Compasses first at g , and opening the other foot to e , and so set off the occult line ei ; then remove one foot of your Compasses to the point h , and extend the other to the point f , which distance hf transfer also into the Base, as to k : Then draw Visual lines from the point c to the Perpendiculars ge and hf , and Diagonal lines from the point b (on your right hand) to the transferred distances ik in the Base; and where the Diagonal bi cuts the Diametral cg , as here it does at l , shall be the Angle in Scenographic that represents the Angle e in the Geometrick Triangle: and where the Diagonal bk cuts the Diametral ch as here it does in m , shall be the Angle in Scenographic that represents the Angle f in the Geometrick Triangle. The other Angle in Scenographic lies at the Base, at the Angle d of the Geometrick Triangle: therefore a straight line drawn from d to m , shall be the representative of the side df ; and another straight line drawn from d to l , shall be the representative of the side de , and another straight line drawn from l to m shall be the representative of the side ef .

In the other Triangle with one of its Sides against the Base; you see there is no more to do but to erect a Perpendicular from the Angular point e into the Base as eg , and transfer that distance into the Base as to i , for then by drawing a Diametral from c to g and a Diagonal from b to i : you have at the intersection of the Diametral with the Diagonal (as at h), the three Angles of your Scenographick Triangle: h represents e in the Geometrick Triangle, and d and f are the same; and straight lines drawn from b to d , and from b to f , together with part of the Base df be the Sides of the Scenographick Triangle.

OPERATION VI.

Height and Distance given, to describe the Scenographic of an Hexagon in two positions, one with an Angle against the Base, the other with a Side against the Base.

Draw your Base as aa , and at your given Height the Horizontal line as bb , and in it place your Visual point as at c , and points of distance as bb , place your Hexagon as $d e f g h i$ with one of its Angles under the Base as the Angle d : then draw Perpendiculars from each Angle of the Hexagon into the Base as $f e k$, $g d$, and $h i l$, and transfer the distance of each Angle from the Base to the Base, as before in the several operations: for then Diametral lines drawn from the points where the Perpendiculars touch the Base, and Diagonals from the transferred points in the Base shall by their mutual intersection, give the Angles of the Scenographick Hexagon: and straight lines drawn from Angle to Angle shall shew the Figure. The several Angles of the corresponding Figure are marked with Roman Letters as $e f g h i$.

The other Hexagon with one of its sides against the Base, is also made by erecting Perpendiculars from each Angular point in the Figure, and transferring the distance of each Angular point from the Base to the Base, for then Diametrals drawn from the Perpendiculars in the Base, and Diagonals from the transferred distances in the Base shall at the intersection of each Diametral with its respective Diagonal give the Angles of the Figure: That is, where the Diametral drawn from any Perpendicular shall intersect that Diagonal that is drawn from the transferred distance of that Perpendicular shall be the point where the Angle shall be placed that represents in Scenography the Angle from whence the Perpendicular was erected on the Geometrick Figure. As you may see by the corresponding Roman and Italic Letters.

OPERATION VII.

To describe the Scenographic of a Pentagon, in two several Positions, one with a Side, another with an Angle against the Base.

Describe your Base as aa , and Parallel to it at your intended Height as ab , describe the Horizontal line as bb , and elect your Visual point as at c , and on either side as at bb by your points of

of distance; then draw a Geometrical Pentagon with one of its Angles as *d* against the Base, and from all the rest of its Angles viz. *e f g h* erect Perpendiculars into the Base, which Perpendicular distances from the Bases transfer into the Base, (as you have in the foregoing *Oper.* already been taught.) Then from the Visual point *c*, draw Diametrals to the Perpendiculars in the Base, and Diagonals from the point of distance *b* on your right hand to the several transferred distances on the Base, and the interfections of these Diagonals with the respective Diametrals shall be the respective Angles of the Scenographick Pentagon: And straight lines drawn from Angle to Angle shall include the Scenographick Figure.

The other Pentagon with one of its Sides against the Base, is also made by erecting Perpendiculars into the Base, and transferring the length of each perpendicular from the point where it cuts the Base to the Base; for then Diametrals drawn to the Perpendiculars in the Base, and Diagonals to the several transferred distances shall at the interfection of each Diagonal with its respective Diametral give the Angles of the Figure: That is, where any Diagonal (drawn from any transferred distance on the Base,) shall intersect the Diametral drawn from the Perpendicular (on the Base,) of that transferred distance, shall be the point where the Angle shall be placed that represents in Scenographie the Angle from whence the Perpendicular was erected on the Geometrick Figure: and straight lines drawn from Angle to Angle shall inclose the Scenographick Figure. As you may see by the corresponding Romain and Italick Letters.

OPERATION VIII.

Height and Distance given, to Describe the Scenography of an Octagon, with one of its Angles against the Base: and another with one of its Sides against the Base.

THis Operation is also performed as the other, viz. by drawing Perpendiculars from the Angles up to the Base, and setting off the distance of the Angles from the Base on the Base:

For then by drawing Diametrals from the Visual point to the Perpendiculars on the Base, and Diagonals from the point of distance set off on the Base, you have in their mutual Interfections given the Angles of the Scenographick Octagon; and straight lines drawn from Angle to Angle shall shew the Figure. As you may see by the corresponding Romain and Italick Letters.

The other Octagon is also made by drawing Perpendiculars from each Angle up to the Base: And (as before) transfer the Per-

pendicular distances of every Angle from the Base to the Base. Then from the Visual point draw Diametrals to the Perpendiculars in the Base, and from the point of distance Diagonals to every transferred distance on the Base, so shall the mutual intersections of each Diametral, and Diagonal give the Angles of the Octagon, and so much of the Visual raies and lines of distance as are comprehended between every two Angles shall be the several Sides of the whole Figure.

By this *Operation* therefore you may perceive an Octagon with one of its Side against the Base, is readier to be drawn than any other Figure: Because in all other Figures after you have found the several Angles of the Figure, you must draw straight lines from Angle to Angle to represent the Sides: But herein you describe the Angles and Sides all at once. And hereby you may (if you will consider it) apprehend the nature and quality of the three most principal Lines used in Perspective viz. the Parallel or Fore-right Line, the Return Line, and Diagonal Line: For as was said in the *Preface*, those Lines that are Parallel to the Base in a Geometrick Figure, must be Parallel to the Base in the Scenographick Figure: And those Lines that return from the Base right Angularly in the Geometrick Figure, must in the Scenographick Figure be drawn from the Visual point, and Diagonal Lines viz. those lines that cut off a part of the two sides of the Right Angle at equal distance from the Angle in the Geometrick Figure, shall be drawn from the points of distance. Thus you see the Lines *de* and *ih* in the Geometrick Figure are Parallel to the Horizon: so are their representatives *de* and *ih* in the Scenographick Figure: And thus you see the lines *fg* and *lk* in the Geometrick Figure Perpendiculars, and their representatives *fg* and *lk* in Scenographic are drawn from the Visual point. Also thus you see the Diagonal Lines *ef*, *gb*, *ik*, *ld*, in the Geometrick Figure represented by part of the Diagonals *ef*, *gh*, *ik*, *ld*, in the Scenographick Figure.

OPERATION IX.

Height and Distance given, to Describe a Circle in Perspective.

Describe first a Geometrick Circle, and divide it into twelve equal parts as 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, through each one of which divisions let fall a line Perpendicularly on the Base, as through the point 1, draw the line which also runs through the point 7, through the point 2 which also passes through the point 6: and so for the rest, as you may see in the Figure.

Then from the point 2 to 3 draw a Diagonal Line and continue it into the Base, and from the point 1 to 4 draw another Diagonal Line, which also continue into the Base. So is the Ichnography of your Circle fitted for your purpose.

For

For describing the Scenographic of this Circle, let fall a Perpendicular upon the Base from the Visual point *c*, and from that Perpendicular set off on the Base each way the distance of each Perpendicular from the point *i* in the Geometrick Circle; and to those distances draw Diametral Lines from the Visual point *c*: then set off on the Base the distances of the several Diagonal Lines from the point *i* in the Geometrick Circle, and to those distances draw Diagonal Lines from the point of distance *b*. And the intersections of those Diagonal Lines with the respective Diametral Lines are the points through which the Scenographic of the Circle is to pass.

Note, That though this Geometrick Circle be placed on the Base, it is all one in effect as if it had been placed under the Base, as the other Geometrick Figures delineated in Perspective are: for the distance of every point from the Base would be the same. In the foregoing Figures you have all the points of the Figures drawn up into the Base by Perpendiculars erected, and in this for want of room to place it under the Base the several points are transferred downwards to the Base from the point *7*, on either side the Perpendicular *i 7*.

OPERATION X.

Another way to draw the Perspective of a Circle at any Assigned Height and Distance.

DRAW your Base and Horizon, as hath been taught before: and having assigned your Visual point, and points Distance, Draw on a Center in the Base a Semi-circle; This Semi-circle must be included in half a Quadrat, as in the Figure; and divided into as many equal parts as you please, (the more the better) this Figure is Divided into eight, as *defghiklm*, and through every point of division must be a line drawn Perpendicular to the Base and continued to the outmost verge of the half Quadrat: These several Perpendiculars must be crossed at right Angles with other lines Parallel to the Base, and drawn through those points of division in the Semi-circle that are equidistant to one another: So is your Geometrick Semi-circle finisht. Then from the Visual point draw Diametral lines to the several points where every Perpendicular touches the Base, and also two Diagonal lines from the points of distance *bb* to the points where the Semi-circle touches the Base, so shall the intersections of those two lines with the Visual lines be the points through which you must draw lines above the Base Parallel to the Base (as in *Oper. XV.*) and the intersections of those respective Parallels with the respective Diametral or Visual lines are the points through which the Scenographick Semi-circle is to run, as at *defghiklm*, which is one half of the Scenographick Ground. The other Scenographick Semi-circle is drawn through the intersections of the Diametrals with the Parallels in the under half of the Scenographick Ground.

OPERATION XI.

Height and Distance given, to Draw the Perspective of a Flat Oval.

Divide the Circumference of the Oval into so many equal parts as you please, the more the better ; (In this example we have 16,) and mark them with 1 2 3 4 5 &c. from these points raise Perpendiculars into the Base, and transfer the distance of each Perpendicular from the Base to the Base : Then from the point of distance *c* draw Diametrals, to the several Perpendiculars in the Base, and Diagonals to the transferred distances of those Perpendiculars, and the mutual intersections of the Diagonals with the respective Diametrals shall give the several points through which the Scenographick Oval must pass: as where the Diagonal drawn to the point 1 on the Base cuts the Diametral drawn to the point 1 is one point through which part of the Circumference of the Scenographick Oval must be drawn : and where the Diagonal drawn to the point 2 on the Base cuts the Diametral drawn to the point 2 is another point through which part of the Circumference of the Scenographick Oval must pass. The like is to be understood of all the other Diametral and Diagonal Intersections.

OPERATION XII.

To Describe an irregular Figure in Perspective, Height and Distance given.

THe Angles of this Figure are *defghiklmno*, which erect Perpendicularly into the Base (as before,) and also transfer their Perpendicular distances from the Base into the Base, for then Diametrals drawn to the Perpendiculars and Diagonals to the transferred distances cut each other respectively in the Scenographick points where the Angles of the Figure must be placed, and lines drawn from Angle to Angle shall include the Figure. As you may see by the corresponding Romain and Itallick Letters.

OPERATION XIII.

To begirt the former Figure with Parallel Lines about it, in Perspective: Height and Distance given.

THese two Figures are inserted to shew that whether your Figures are regular or irregular, Circumscribed or not Circumscribed, the working remains the same in all respects:

For as in the foregoing Figures, so in this, Perpendiculars erected from the Angles, and the distance of the Angles from the Base transferred to the Base, and Diametrals drawn to the Perpendiculars in the Base, and Diagonals to the transferred distances cut each other in those points the Scenographick Angles must be placed, from whence lines drawn to each other respectively shall begirt the former Figure with a line Scenographically Parallel to it.

I have been the more copious upon these Figures because they come often in use in the designing of Ground Plots, whereon to raise any Structure in Gardening, and in Fortifications. &c.

OPERATION XIII.

Shewing that from one Geometrick Figure you may make two or more Scenographick Figures by Elevating of the Horizon.

YOU were taught in *Oper. VIII.* to reduce the Geometrick Octagon *defgbikl* into Scenographie, which is here also noted with its corresponding Romain Letters. But you may make yet another appearance of this Figure, if you alter the Height though you observe the same distance, for here the Horizontal line is elevated into the upper *bc*, and Diametrals drawn to the same Perpendiculars, and Diagonals to the same transferred distances, by their mutual intersections give the points *FGHIKL* which are the Angles of the second Octagon, and lines drawn from each Angle to its next shall include the Figure.

This way of working may be of great use in drawing Covers for Boxes, Covers for Pulpits, and for several other designs, for according to your purpose you may either elevate or depress the Horizontal line, or make as many elevations as you please.

OPERATION XV.

To Describe the Scenographie of a Plain with Seven Quadrats or Squares in Length, and Seven in Breadth therein: Height and Distance given.

THe given Height is ab , and the given Distance cb , draw the Base aa and Parallel to it at the given Height the Horizontal line bb , then set off the distance with your Compasses from the middle of the Horizontal line both waies, as from the Visual point c to bb : And keeping one foot of your Compasses still in the Visual point, set off your designed length of the Base as at aa on either side making small occult arches or markes on the Base; then draw two Diagonal lines from the points of distance bb to the points aa , and two Diametrals from the Visual point c to the points aa , and where the Diagonals ba cut the Diametrals ca , as here in the points dd and aa shall be the four Angles of this Scenographick Plain, and a straight line drawn from d to d shall be one side of this Plain: The Base line aa another side, and two lines drawn viz. one from a to d on the right hand, and another from a to d on the left hand shall be the other two sides that include this Square. Then divide the Base into Seven equal parts, as from a to $efghik$; and by laying a Ruler on the Visual point c and each of these parts $efghik$ draw by the side of it Diametral lines through the Plain, and to the points where those Diametral lines intersect the two Diagonal lines ba and ba (as here they do in $123456d$. $123456d$) lay a Ruler and draw lines by the side of it Parallel to the Base, so shall your work be finished.

OPERATION XVI.

Height and Distance given, To Describe the Scenographie of a Plain full of Squares with their Angles pointing against the Base.

THe given Height is ab , the given distance c : Draw the Base aa as before, and at the given Height Parallel to it the Horizontal line as bb ; then take the middle of the Horizontal line for the Visual point as at c , and set off your distance as at b on either side c : Then let fall a Perpendicular through the Base as cd , and from the point d divide your Base into as many equal parts as you please both waies (as here into 6 each way marked with $12345a$;) then

Then draw the two Diametrals to the points $a a$, and two Diagonals from the points of Distance $b b$ to $a a$, and where these two Diagonals $a b$ cut the Diametrals $c a$ (as here in $e e$ and $a a$) shall be the four angles of the Scenographick Plain; and a straight line drawn from e to e shall be one side of the Plain, the Base $a a$ is another side, and part of the Diametrals viz. from a to e on either side shall be the two other sides of this Scenographick Plain. Then laying a straight Ruler to both the points of Distance and all the divisions on the Base, Draw lines from those divisions to the Diagonals, so shall half your Plain be filled with Squares. To fill the other half, You must lay your straight Ruler to the several intersections of the Diagonals with the two Diametrals on either side the Plain, and draw straight lines into the side of the Plain $e e$, so shall the other half of your Plain be filled also.

The making of these two Scenographick Plains full of Squares is of great use in Perspective, for the ready designing and placing all sorts of Buildings and moveables in their proper distances one from another, and in their various appearances to the Ey: For in the designing of Stools, Tables, Crosses, and many other Figures your labour is as much facilitated as by copying a Picture when it and what you draw on are divided into squares, and is indeed virtually the same thing. For instance, If you designe each side of one of these Squares to be an Inch, a Foot, or a Yard &c. long; then what Object soever is placed one Square distant from another is said to be either an Inch a Foot or a Yard &c. distant: What Object is placed two Squares off is placed two Inches &c. distant. And so for any number of Squares.

Again, For the various appearance to the Ey. All Buildings or Moveables whose fore-sides are situate in an Orthographick Plain are drawn upon the Squares in Operat. X V. because the fore and back sides of those Squares ly in an Orthographick line. As you may see the Cubes in Operat. X I X. and the Buildings in Operat. X X. X X I. X X I I. X X I I I. X X I I I I. X X V. X X V I. X X V I I I. X X I X. X X X. X X X I. X X X V I I I. and the Moveables in Operat. X X X I X. But those Buildings or Moveables whose corners ly in the Orthographick Plain, that is, whose front declines from an Orthographick line are best placed on this Scenographick Plain that hath its angles against the Base. As you may see in Operat. X L. X L I. X L I I. and X L I X.

In these two Plains you may see how the several distances of the Object alters its appearance: for all the several appearances of those Squares are but the several appearances of the Squares $g h l m$. in the last Operation, and $d f g h$ in this, whose points are transferred into the Base, and made as in the foregoing Operations.

OPERATION XVII.

Height and Distance given, to Draw a Scenographick Ground-plain in Squares, each Square being begirt with Frame-work.

DRAW first the Base ab , and Parallel to it at the given Height the Horizontal line, in which from your elected Visual point set off your distance as cd , then place one foot of your Compasses in the Visual point and extend the other on either side the Base to what width you intend your Geometrick Squares with its Frame-work about it shall be, as to a and b . Then draw your Geometrick Squares with its Frame-work: but you need not draw the whole Geometrick work in depth; for the Visual point being placed just Perpendicularly over the middle of the Geometrick Draft each half is exactly alike, and therefore one half will serve as well as both. Having drawn your Geometrick Draft, draw first Diametral lines from the Visual point to the points a and b , which shall be the limits of the length of the Scenographick Ground-plain: Then draw Diagonal lines from the point of distance d on either side the Visual point also to the points a and b ; and where those Diagonal lines intersect the Visual or Diametral lines as in ef , draw a line Parallel to the Base: and it shall limit the depth of the Scenographick Ground-plain: then draw Diametral lines from the Visual point to every point where each Perpendicular of the Geometrick Figure touches the Base, and if to those points where these several Diametral lines cut the two Diagonal lines, you lay a Ruler and draw a line by the side of it those lines will be Parallel to the Base, and shew the true Scenographie of the whole Geometrick Figure.

OPERATION XVIII.

Height and Distance given, to Draw in Scenographie a Ground-plain full of Squares, with their Angles against the Base: each Square being begirt with Frame-work.

HAVING described half the Square abc with the Angle against the Base, draw the Base dd , and Horizontal line ee as by the last *Oper.* and set off your points of Distance ee from the Visual point f , then continue the straight lines of your Frame-work bg, cg , and all the other lines Parallel to them into the Base; and

Diagonal

Diagonal lines drawn from the points of distance ee , to the points $g b i k a l m n g$ shall perform your Operation: as you may see in the Figure.

These two Figures are of great use in the Designing of Buildings, for placing Columns, Pilasters, Peers, &c. or for dividing of Houses, Rooms, &c.

OPERATION XIX.

To describe the Appearance of three Cubes in Perspective standing directly forwards on the Base.

Draw a Ground-plain of six Squares as you were taught by *Oper. XV.* Then draw a Geometrick Square standing on the Base as i , whose Angles are marked with $a b c d$, and from the points $e f$, erect two Perpendiculars as eg, fh , then draw Diametrals from the Visual point v to b and c , and the intersections of those Diametral lines with the Perpendiculars $a b, c d, eg, fh$, shall be the points, from whence straight lines drawn (as you may see in the Figure) shall include the Cube.

The Cube K standing more directly afore the Ey hath another Appearance, yet is the manner of working with Diagonals and Perpendiculars the same.

The Cube L being a hollow Cube (or as it were a) Box without a top-cover, stands also on a Square, as $l o n m$, whereon the Perpendiculars $l l o o n n m m$ must be erected, and Diametrals drawn from the Visual point to the intersection of these Perpendiculars, so shall straight lines drawn from these intersections (as in the Figure) include the Cube: But the thickness of the Boards you must set off in the bottom of the Cube Parallel to the Base as qp and rs , and make of these another Scenographick Square, by drawing Diametral lines $qr p s$, and in the Angles of this second Square erect the four Perpendiculars $q q r r p p s s$ and from the Visual point draw Diametrals to intersect them in the top of the Box as $p q s r$, and straight lines drawn from intersection to intersection shall include the thickness of the Boards as they appear from the height v and distance t .

OPERATION XX.

To describe the Scenographick appearance of the inside of a Chamber.

This is performed by help of a Ground-plain of Squares made by lines drawn from the Visual point a , and the point of Distance b to the Base, as by *Operat. XV.* This Ground-plain contains seven Squares in length h , and seven in breadth, whereof

the thickness of the wall on either side takes up one quarter of a Square, as is seen at *a b*. In the Wall is made a Door, containing in breadth three Squares on the Ground-plain, as *s x t v*; and if you draw two lines from the opposite angles of the Door, where they intersect each other shall be the middle of the Door; as you may try on the other side of the Wall, where lines drawn from *f b* and *g i* intersect each other at *k*, which by the Perpendicular *k l* you may find falls in the middle between six Scenographick Squares: that is, three is contained between *l* and *i*, and three between *l* and *f*.

In the furthermost side of the Wall is a Thorow-fare made of the same height the Door is, by drawing the Diametral *t v* from the Visual point *a* and continuing it to *e* at the angle of the two Walls, and from thence by drawing the line *e d y* parallel to the Horizon, which Thorow-fare (being of the width of three Squares, as between *e* and *z*) is described by erecting Perpendiculars from the points *e z* to cut the Parallel *d y* in the points *d y*, as you may see in the Figure: And so the Thorow-fare *d y e z* Orthographically becomes equal to the Scenographick Door *t v s x*.

To bear up the Roof of the Chamber, here is described five Joysts laid upon the side of the Wall, *q b* the depth of which Joysts are described by the Perpendiculars *q r* and *p o*, and the breadth by *m q* and *o b*; each Joyst is of equal breadth, and lies of equal distance one from another, so that by laying a Ruler to the Visual point and the points *m q r*, you may draw the lines *f m*, *g q*, *h r*, to represent the three corners of the first Joyst. The fourth corner lies out of sight. Do the like for the rest of the Joysts, all but the middlemost, which because the Ey lies just under it shews but two of its corners; as you may see in the Figure at *n*. Then if you will cover these Joysts with Boards, or Plancks athwart, you may for your better guidance divide the Ceiling into four Scenographick parts by drawing lines from the Angles *n i* to the the Angles *r p*; for where they intersect one another as in the point *k*, draw a line Parallel to *r p*, and that line divides the Ceiling into two Scenographick halves: And other lines drawn from the points *h i r p* to the two ends of this Parallel *l m* do by their intersections give points on the middle Joysts through which two lines drawn Parallel to the line *r p* divide the whole Ceiling into four Scenographick parts as you may see in the Figure.

I have been the more Copious upon this *Operation*, because it is the first in this Book that shews the drawing of inward Edifices: And I would have you well understand it; because I intend instead of Repetition to refer you to this *Operation* when I shall have occasion to speak of things of the like nature.

OPERATION. XXI.

*To describe the inside of a Chamber with three Doors,
one on either side, and one right before.*

THis is performed upon a Ground-plain of nine Squares in length and nine in breadth, (drawn as by Operat. XV.) I shall not need say any thing of the sides of the Wall, it having been taught in the last Operation: But the Doors standing partly open and partly shut require a little instruction to shew the designing of them in Perspective.

You must understand that a Door being hung upon hinges describes in its opening and shutting a Semi-circle. As for Example, If it stand wide open with the back side of it against the Wall, it fetches the sweep of a Semi circle before it can shut upon the Door-frame that runs range with the Wall. Therefore having the width you intend your Door shall be of, and pitcht upon what place in the side of a Wall it shall move, (as on its Axis,) you need but describe on a loose paper a Geometrick Semi-circle in the same number of Squares that you intend your Door shall describe its Semi-circle in, and observe the points of the Parallels and Perpendiculars that this Semi-circle cuts, for the Scenographick Semi-circle must pass through the same points of the Diametral and Diagonal lines described on the Scenographick Ground-plain: As you may see the Door *aa dd*, containing six Squares (as from the center *a* to *e* three, and from *a* to *f* three) describes on the Ground-plain the Semi-circle *elbidgf*, which if you draw a Geometrick Semi-circle in six Squares you will find that this Scenographick Semi-circle passes through the same points of Diametrals and Diagonals as your Geometrick Semi-circle does through Parallels and Perpendiculars. Then consider how neer open or shut the Door is you intend to describe; that is, what angle it makes with the Wall; for the same quantity you must set off on your Scenographick Semi-circle; as here it stands open by the distance *fdg*: Therefore draw a straight line between *a* the center the Door moves on and *d* the edge of the Door, and prolong it into the Horizon, and that line *da* shall be the under side of the Door: Then describe the same Semi-circle over the Door that there is on the Ground-plain, by erecting Perpendiculars from as many points as you please of the Semi-circle on the Ground-plain, and by drawing straight lines from each of those points into the center *a* and prolonging them into the Horizon; for where the Perpendiculars cut straight lines drawn from those several points in the Horizon through the upper center *a* of the Door and so prolonged shall be the points that the upper Scenographick Semi-circle *elidgf* must run through.

If you would have the Door stand wider open that you may see more of the entrance as at *ii*, Draw (as before) a straight line from *i* to the center *a* and prolong it into the Horizon, as *ia k*, so shall be

the under edge of the Door; and if from the point *i* you erect the Perpendicular *zi* for the edge of the Door, a straight line drawn from the point *k* in the Horizon to the point *a* in the upper center of the Door and prolonged shall give the line *za* for the upper edge of the Door.

Thus may you describe a Door standing open to what width you please, as at *aa ee* the Door stands wide open with its back side against the Wall; at *aa ll* it shews less open; at *b h* it shews a Door whose edge lies almost in the same line its Axis does, and so the Door shuts neerer and neerer, as at *gg aa* the Door appears quite shut: the Door on the other side is made just after the same manner, and therefore needs no more Descriptions.

The Door in the middle stands also on three Squares, and also opens through six, and if you describe the Scenographick Semi-circle *mpq* as you were taught just now you may set this Door also open to what width you please. Thus, Erect a Perpendicular on the point of the Semi-circle you intend to open the Door to, and prolong it quite through the Door as *rns*, and with your Compasses measure on the Perpendicular, the distance between that point in the Semi-circle and the Diameter of the Semi-circle, which is the line *mn*, where the Squares end; for that distance set off on the same Perpendicular from the Base as from *r*, shall give a point through which a straight line drawn from the Center of the Door *o* to the Horizon shall be the point in the Horizon from whence a straight line drawn to the upper end of the Doors Axis shall give the shortning of the upper edge of the Door, and the points where the two straight lines cut the Perpendicular shall be the points that shall shew the shortning of the fore edge of the Door.

Above this Door is made a round Hole of the same width the Door is, and of the thickness of the wall; which because the lines by which it is made, are so plain and the manner of working so easie I shall forbear farther Instructions on it.

Under this Arched Roof are drawn Parallel prickt lines to shew the divisions of the Roof: and by these divisions either with Compasses, or else a steady hand, you may describe the Arches as you may see them in the Figure.

By the making the foresaid Doors may be understood how to make Casements standing open at any width; and several other Operations pleasant and necessary for all that Study Perspective.

OPERATION XXII.

To Describe in Perspective the inside of two Chambers one above the other.

THis is also performed by help of a Ground-plain, as in the former Figure: but the difference between this and the former is. 1. This hath another Chamber over it. 2. A Portal

Portal and Hole on one side of the Wall, and another right before you on the middle of the Ground-plain. 3. Steps placed just within this Portal. 4. A square Hole in the middle of the Ground-plain. 5. Shelves on the other side of the Chamber.

1. For what concerns barely the Chamber over the lowermost Room you may see by the Figure that its Operation is the same with the former; where you see all the three sides of the Chamber wholly, but because the Ceiling *abcd* of the lower Room lies so much above the Ey, you only see so much of the upper Chamber as is un-obscured by the Ceiling. That is, all above the Catuzes *ad* resting on the two Catuzes *e f*; the rest are only noted with prickt lines, as they would appear if the Ceiling were not interposed between the Ey and them: and the Joysts over head are wrought as in the last *Operat.*

2. For the Portal on the side of the Wall you may see that it stands on three Squares on the Ground-plain, as doth the Portal right before you. Now to make the Arch over this Portal correspond with the Arch of the Portal right before you, viz. of the same height as that Portal is, do thus. Draw a line just where the Arching begins parallel to the Horizon as *gh*, and prolong it to the corner of the fore-right Wall as at *g*. Then laying a Ruler to the Visual point and the point *g*, describe the line *mg*, then draw another Parallel line on the top of the Arch of the Portal and prolong it also to the corner of the fore-right Wall as to *i*, and laying a Ruler to that point *i* and the Visual point draw the Diametral line *no i*, then erect two Perpendiculars *nl* and *om* from the sides of the Portal to intersect these Diametrals, so shall you by crossing the Angles of intersection have the Center *p*, and upper and lower bounds of the Arch; which a steady hand may easily reduce into form.

This way of working is exact enough for Painters or other Artificers. But if you will be yet more precise, See *Oper.* XXV. XXVI.

The Hole in the side of the Wall in the upper Chamber is made after the same way, viz. by erecting Perpendiculars to the designed width, as here it is three Squares on the Ground-plain, (the same with the Portal) and by drawing Diametrals from the Visual point for the depth of the Hole; for where the Perpendiculars and Diametrals intersect each other shall be the Angles of the Square that includes the Hole, and straight lines drawn from Angle to Angle shall intersect each other in the Center of the Hole.

By the same way of working you have the back side of this round Hole described to the thickness of the Wall, and also the back side of the Portal (as you may see in the Figure).

In the other side of the Wall on the Ground-plain is made another half-round Hole; which being performed after the same manner needs no further Explanation.

3. Just within the Portal are placed four Steps going straight upwards; which are thus made. Draw the two slope lines *qq* and *rr* (to what slope you please) parallel to each other for the width of the Steps: then assigne a depth for the first Step, as to *s*, and Parallel to

the Base draw a line for the breadth of the Step, as ts , then draw Diametrals from the points s and t to the slope line qq , so shall the first Step be made. The rest of the Steps are made after the same manner; observing that all the several Steps on their several Perpendiculars are equal in depth to the first.

4. In the middle of the Ground-plain is made a square Hole as v xz , which may serve for an Entrance down a pair of Stairs leading to some Vault or Cellar. These Stairs are in length three Squares, and in depth the transferred distance of one Square, as you may see the depth of the first Step downwards is vx , which is the transferred distance of vy , the breadth of the Step is xa ; so that a Diametral drawn from the Visual point to x and so prolonged directs you to the second Step at b , and by placing one foot of your Compasses at the point c , which is in the same Diametral the point v is, and extending the other to the point d (which also is in the same Diametral the point y is) you transfer the distance of dc to cb which is the distance yv transferred to vx ; and another Perpendicular erected from the point b to c shews the depth of the second Step. The rest of the Steps are made after the same manner.

5. On the other side of the Chamber against the Wall is set three Shelves, two above the Horizontal line, and one below, as efg : The further ends of them rests in the Wall right before you, and the hither end is fastned to a Post erected Perpendicularly on the Ground-plain; the breadth of these Shelves are one Square on the Ground-plain, as you may see by the line hi , from which Diametrals prolonged to the Post the several Shelves are described.

Here you may note that by the several places of these three Shelves you have several appearances of them; for the Shelf g lying under the Horizon shews its upper Plain. The Shelf f lying a little above the Horizon shews its under Plain, though much fore-shortned. The Shelf e lying pretty high above the Horizon discovers the under Plain more intirely. But on the other side the Wall you have the Shelf k , which because it stands just in the Horizontal line discovers neither the upper or under Plain, but only the very edge of the Shelf.

OPERATIO N XXIII.

The manner of placing Columns behind one another in Perspective.

THough this may be performed by a Ground-plain of Scenographick Squares, (as before,) yet because in this Operation no work comes between the two rows of Columns we shall need describe no more of the Ground-plain than will serve our turn.

Therefore having drawn your Horizontal line to your designed Height

Height above the Base, and set off your points of Distance at equal distance on either side the Visual point, Draw the Diametrals aa , bb , cc , dd , Then from the points of Distance draw the Diagonals $e d$, and $f a$, and at the points of intersection of these Diagonals with the Diametrals draw straight lines parallel to the Base, and these straight lines continued to the outmost Diametrals shall make four Scenographick Squares, whereon four Columns must be placed; as here the Squares ab and cd and g and h &c.

If you would have more Columns stand behind these four, Draw Diagonal lines from the innermost Angle of the hindmost Squares already made, as from g and h , and those Diagonals shall intersect the Diametrals in $c d$ and $b a$, from which angles of intersection straight lines drawn parallel to the Base and Horizon shall make the Scenographick Squares whereon two other Columns shall stand.

By this manner of working you may set more Columns behind these, till you almost fill the whole Ground-plain.

Having thus projected these Scenographick Squares whereon the Columns must stand, you must erect Perpendiculars from every angle of these Squares through the Horizontal line and so upwards to the height your outmost Column ought to be, as here to the line ik parallel to the Horizon; for the points where Diametrals intersect this line and the Perpendiculars ai and dk shall be angles impending perpendicularly over the respective angles of each respective Square in the Ground-plain: As here the angle i hangs directly over the angle a , and the angle k hangs directly over the angle d : Then from the points of Distance draw Diagonal lines to the points ik , and where those Diagonals intersect the Perpendiculars erected on the Diagonal angles of the Square in the Ground-plain must another line be drawn parallel to the Horizon, and also other Diagonal lines which shall include the Squares that hang over the two first Squares in the Ground-plain.

The other Squares are found after the same way, viz. by the mutual intersections of the Diagonals with the Perpendiculars. As may be seen in the Figure.

The Arches over these Columns are very easily made: for by drawing the Perpendicular through the Visual point in the Horizon into l you have all the lines drawn parallel to the Horizon divided into two equal parts, And by placing one foot of your Compasses in the middle of the respective Parallel lines and opening the other to the angles of the Square that lies in the same Parallel line you may describe those respective Arches. As for example. If you place one foot of your Compasses in the middle point on the line ik and extend the other to the point i or k you may describe the outmost Semi-circle, and by closing the Compasses to the other angle of the Square which lies in the same line, you describe the second Semi-circle; for the third Semi-circle you may place one foot of your Compasses in the middle of the next parallel line and extend the other to the point o in the same line, and describe the Semi-circle op . This work

is so plain and easie to be understood by the Figure, that I need discourse no further upon it.

In this Figure you may note, what correspondence the Squares above the Horizon have with those below the Horizon. Yet as the Squares above the Horizon have a greater distance from the Horizon than those below the Horizon have, it falls out that the upper Squares are larger than the under Squares: The reason whereof you may easily see by consulting the Figure.

And as the Squares have a correspondence, so also have the Diagonals; for the crossings of the Diagonals above the Horizon respond with the crossings of the Diagonals below the Horizon.

OPERATION XXIII.

To describe in Perspective the appearance of four Pilasters, with four Beams upon them; And to make an Arch over them.

THis is also performed by a Ground-plain of Squares, which consists of seven in breadth and seven in depth: Described as by Operat. XV. The Pilasters *ab* and *cd* standing each on one Square erected perpendicularly on the angles of the Ground-plain, and divided upwards into three equal parts, as 1 2 3. with straight lines parallel to the Horizon drawn through the fore-side of them: But the lines that divide the inside the Pilasters are Diametrals drawn from the Visual point to the inmost corner of the fore-side of the Pilaster. As you may see by the Figure.

Upon these Pilasters is laid a Frame of four Beams, serving for bond to the Pilasters, as *efgh*, two of which viz. *fb* are drawn from the Visual point. And over these four Pilasters is erected the Arches *ikl* and *mno* to be seen quite through; which Arches being to be made as those in Operat. XXI. XXIII. need here no further discourse on them. Only you must note, that what lines of divisions you make on the Orthographick or fore-side of the Arch you must draw from the center of each respective Arch, and the divisions on the under side of the Arch must be drawn by the side of a Ruler laid to the Visual point and to the division on the corner of the fore side the Arch, as the divisions of the Pilasters are.

OPERATION XXV.

The manner of making Side Arches in Perspective.

HAVING drawn an Horizontal line, describe a Ground-plain of Squares, (as by Operat. XV.) and thereon draw a Scenographick Circle (as you were taught by Operat. IX. X.) and mark it from the middle line with 1 2 3 4 5 on the Base; and on the

the side with *abc defgh*: Then erect a Perpendicular on the corner of the Ground-plain of the height you intend your side Wall shall be as *hi*, and erect another Perpendicular on the corner of the Ground-plain as *55*, and by drawing two Diametrals through the Visual point the point *z* and the point *5* on the top, and from the Visual point through *b* to *5* on the Base, you shall have the Scenographick appearance of the side of the Wall wherein the Arch shall be made. Then from the point *h* (which you may see by the Orthographick or fore-right Arch is the point where the Arching begins,) draw another Diametral into the Perpendicular line *55* as *h1*, and you will find the same distance between *15* on the Perpendicular as there is between *15* on the Base: But the rest of the distances you must transfer, as the Distance between *12* on the Base you must transfer from *1* to *2* on the Perpendicular, and the distance *13* on the Base you must transfer from *1* to *3* on the Perpendicular: And so for the rest.

Then from the points *abc defg* on the Ground-plain erect Perpendiculars into the Ceiling and where Diametrals drawn from the points *12345* intersect these several Perpendiculars shall be the points through which the Arch must pass. For Example. Where the Diametral drawn from the point *2* on the Perpendicular intersects the Perpendicular erected on the point *a* on the Base, as here it doth in *a*, shall be one point through which the arching must pass, and where the Diametrals drawn from the point *3* intersects the Perpendicular erected on the point *b* on the Base, as here at *b* shall be another point through which the Arch must pass: And so also the intersections from *4* and *5* with the Perpendiculars *cd* in the points *c d*, are points through which the Arch must pass.

For finding the other points through which the Arch must pass, you must go back again to *4* and see where that Diametral intersects the Perpendicular *e* for there shall be another point, and where the Diametrals from *321* intersects the Perpendiculars *fgb* shall be the other points through which the Arch is carried.

Having finisht this Arch the other Arch is easily made, for by drawing Parallels through the points *12345* in the top to the points *klmno*, and also Parallels from the points *abc defgh*, Diametrals drawn to the points *klmno* will intersect the Parallels drawn from *abc defgh* in the points through which that Arch must also pass.

On the Ceiling is made a Circle as it lies below on the Ground-plain of the Floor, as it appears in Perspective at that Height.

On the right hand of the Ground-plain is erected the same two Arches that are on the left hand, whose Operation is in all respects the same: Only on the right hand is drawn straight lines from point to point, and on the left arching lines which makes this on the right hand represent it self (not as an Arch, but) as part of a Figure made up of eight Squares.

OPERATION XXVI.

The making of Cross Arches in Perspective.

IN this Figure is described four Arches, viz. one Orthographick Arch, which is the great Semi-circle marked 1 2 3 4 5 6 7 8 9, an Arch behind it Perspectively diminished, marked 9 a b, and the two side Arches, whose Diametrals are 1 9 and b 9. These four Arches are required to be made before you can make Cross-arching, As in the Operation you will find. Therefore having described the two side Arches (as by the last Operation) you must divide the Orthographick Arch or Semi-circle into eight equal parts, and from the Visual point draw Diametrals to every one of them, as 1 2 3 4 5 6 7 8 9, Then from the points where the Perpendiculars cut the Diametrals of the side Arch, as in 1 2 3 4 5 6 7 8 9, Draw lines parallel to the Horizon to intersect the respective Diametrals of the Semi-circle; for those respective intersections shall be the points through which the Cross-arching must be drawn. As for Example. Draw a line parallel to the Horizon from the point 2 in the side Arch to the Diametral 2 in the Orthographick Arch, and that shall be one point through which the line of Cross-arching must run: Then draw another parallel line from the point 3 in the side Arch to the Diametral 3 of the Orthographick Arch, and there shall be another point through which the Cross arch must run. Then draw another Parallel line from the point 4 in the side Arch to the Diametral 4 of the Orthographick Arch, and there shall be another point through which the Cross-arch must run. Do the like from the points 6 7 8 9, so shall you have all the points through which one of the lines of the Cross-arch must run.

The other Cross-arching viz. the Arch b 8 9 on the other side, is drawn by continuing the Parallels which you drew from the points 2 3 4 5 6 7 8 9 of the side Arch into the Diametrals 9 8 7 6 5 4 3 2 1, for at the intersections of the Parallels with these Diametrals shall be the points through which the line of Cross-arching must pass; which is indeed nothing but the Arch on the other side reversed.

This way of working is very easie, and the truth of it very perspicuous. For as this line of Cross-Arching impends the Diagonals *k l m n* on the Ground-plain, so would you find that if Perpendiculars were erected from the points *o p* &c. on the Ground-plain, they would run into the points where the Parallels and Diametrals cut each other above in the Crossing of the Ceiling which is a proof sufficient to verify the truth of this Operation.

OPERATION XXVII.

To erect a Structure on an Octagonal Ichnographic.

THe Height is $a b$, the distance $b c$. Having described your Ground-plain Scenographically, as by *Operat. VIII.* Erect on the two Orthographick Angles thereof $d d e e$ Perpendiculars to include the side, and through these two Perpendiculars draw a line parallel to the Base and Horizon, at the height you intend your upright work shall break off, as $d e$: And at the intersection of this line with the Perpendiculars $d d e e$, draw lines from the points of Distance b on your left hand to d , and from b on your right hand to e , and from the points where those lines of Distance or Diagonals cut the Perpendiculars $l l$ and $f f$, draw Visual lines to the Perpendiculars $k k$ and $g g$; then from the point of Distance b on your left hand draw a Diagonal from g to the Perpendicular $h h$: And from the point of Distance b on your right hand draw another Diagonal from k to the Perpendicular $i i$. And lastly from i to h draw a line Parallel to the Base and Horizon, so shall the Scenographick Ichnographie of this Building be transferred to the top and all the sides of your Perpendicular Building shall have their Scenographick Heights. You must note that those sides of the Ichnographies that ly behind the Orthographie are to be drawn with obscure lines, only, to direct you in the more true placing the Moldings, &c. in the rest of the work.

The hollow of the Ichnographie is found in the Roof, by erecting Perpendiculars from every point of the Geometrick Circle, and every point of transferred distance to the line of the Roof $d e$, for then by drawing Diagonals through every point of transferred distance afore said, those Diagonals shall cut the Perpendiculars in the several points through which the Circle in the Roof must pass.

The Frame-work of the Spire (as you see) is raised on the upright Angles of the Figure in the Roof, and meets at the Perpendicular erected on the Center of the Scenographick Ichnographie, which you may find as by *Operat. XX.* &c.

OPERATION XXVIII.

To describe a Fabrick supported with Columns.

DRaw a Ground-plain of Squares, as by *Operat. XV.* and on the Squares at the four corners of the Ground-plain, and also on your middle Square erect your Pedestals and Columns, of the true height the Order of the Column you pitch up-

on ought to be : That is, that the Column Pedestal and Capital contain so many Models in length as a Column Pedestal and Capital of the *Tuscan*, *Dorick*, *Ionick*, *Corinthian*, or the *Composite* Order ought to do. Allow also all the Members on the Orthographie or Front their Architect Demensions : and all lines that are parallel to the Base in the Fabrick make parallel in the Figure ; and all lines that are perpendicular in the Fabrick make perpendicular in the Figure :

By lines Parallel to the Base I mean Lines on the Front, or Directly opposite to the Front behind, which must be drawn Parallel to the Base, and not the lines on either side the Front, although indeed they are in the Fabrick as well Parallel to the Base as those in the Front. But those lines in Scenographie are all drawn from the Visual point, and (as you may see in the Figure) fore-shorten those sides they represent.

If you list to erect more Columns behind these, you may draw the Ground-plain of Squares neerer to the Visual point, and by the Rules you have already placed these, set as many as you think good.

OPERATION XXIX.

To Describe in Perspective the Appearance of several Columns placed behind one another.

ALthough you have hitherto been directed to draw a Ground-plain of Squares, yet may it more readily be performed (as you may see in this Figure) by Diametrals and Diagonals without drawing the whole Ground-plain : For by Diametrals drawn from the Visual point *c*, you have the range of the whole row of Columns, and also the range of every member on the Column, and by the Diagonals drawn from *b b* you have the fore-shortning bounded.

As for Example. Having on the Base set off the breadth of the Pedestal as *a d* from the Visual point *c*, draw a Diametral, and that Diametral shall be the range of the whole row of Columns : And by drawing a Diagonal from the point of Distance to the point *a* you have at the intersection of the Diametral with the Diagonal in the point *e* the fore-shortning of the inside of the Pedestal *d e*, then by erecting the two Perpendiculars *d f* and *a g* for the height of the Pedestal, and by erecting the Perpendicular *e h* at the point of intersection with the Diametral *c e d* and the Diagonal *b e a*, and by drawing the lines *f g* and *h i* Parallel to the Base, and the Diametrals *b f* and *i g* you have the Pedestal included in all its visible sides, and the Square *b i f g* shall be the Scenographick Plain of the top of the Pedestal, and the intersection of the Diagonals *b g* and *i f* shall be the Center of the Plain as at *k*.

By this way of working all the other Pedestals are erected, and all their visible and invisible Sides and Angles found. For Example. The black lines are the bounds of the visible Sides and Angles, and the prickt lines the invisible, viz. of those Sides and Angles that ly behind the Orthographie or fore-side of the Pedestal.

Having

Having thus placed the Pedestals you must erect your Columns thereon, and over them the Capitals by erecting Perpendiculars from the Center of every Square plain on the upper side of each Pedestal, and as the several Bases are bounded by Diametrals, Diagonals, and Parallels: so are the several Capitals, and the Centers of their several Plains found by Diametrals, Diagonals, and Parallels; as in the Figure you see the Capitals *lmnop*: which being so very plain needs no further description, especially considering that on the left hand you have the work finisht up according to its true Perspective appearance.

OPERATION XXX.

To Describe in Perspective the Appearance of a Stately Structure.

Here you have on a Ground-plain of Squares described, first, an Ascent of two steps, and on them a Porch with four Columns, as *a b c d*, and arched over with cross-arches. The placing and ordering the Columns has already been taught in *Operat. XIX. XXIII. XXIII*. The chief thing remaining to be treated of is the Cross-arches, which that you may the better understand how to describe in Perspective, You may consider that all Cross-arches are made upon four Columns which stand upon the four Angles of a Geometrick Square, (though here we set them on a Scenographick Square) and that the two Arches that cross each other proceed from the two Columns that stand corner-wise against each other: so that each Semi-circle is cut by the other into two Quadrants. The Orthographick appearance of these Semi-circles viz. the Semi-circle *ef* and *gh*, are described as hath been taught in *Operat. XVII. XIX. XX. XXII. XXIII*, where you may see they are only Arches of Circles, and therefore need no more comment on them, and the other Arches are thus found. Draw a Diametral from the middle of the Semi-circle *ef* as at *i*, and in that Diametral shall be all the intersections of the several Arches that intersect each other, (which as was said before are only those Arches that are made over the Columns that stand corner-wise from one another) Then draw another Diametral from the Center of the same Orthographick Arch *ef* as at *k*, and prolong it towards the Visual point as through *l* and *m* to *n*, for in this Diametral shall be the Center of the Arch *op*, as here in *l*, the Center of the Arch *qr*, here in *m*, the Center of the Arch *gh*, here in *n*. For the Arches *os* and *gs* you must cross the corner Columns *a d* and *b c* in the Floor with two straight lines, and they will intersect each other in *c*, from which point erect a Perpendicular; then from the point *i* in the Orthographick Semi-circle draw a Diametral, and where that Diametral intersects

the Perpendicular as here in *s*, shall be the point where the Arches shall cross each other; and for describing the arch which is alwaies a Quadrant of a Circle, measure with your Compasses the distance between *o* and *s*, and on a loose paper (or other thing) make a Geometrick Square whose Sides shall be equal to that measure, and with a straight Ruler cross that Geometrick Square in its Diagonal Angles; and the distance between the intersection of these two straight lines, and one of the Angles of the Square shall be the Radius to a Circle of the same sweep the Arch *os* shall be of, and the Center of that Arch is found by placing one foot of your Compasses first in the point *o*, and with the other describe an occult Arch, as at *v*, afterwards remove one foot of your Compasses to the other end of the Quadrant and with the other foot describe another occult Arch to cut the former, and in that point of intersection shall be the Center of the Arch *os*. Use the same way to describe the Arch *gs*.

The Columns *xaby* are all set Perpendicularly over the Columns *xaby* and the two Pinacles over the Columns *cd*, as you may see by the prickt Perpendicular lines: so that what remains to be said of this Figure may be understood by the Figure it self, as well as by many words upon it.

OPERATION XXXI.

To describe a Square with Ascents of Steps about it.

A Square that hath Steps to ascend on all four sides hath all the sides of those Steps parallel to the undermost Step: Therefore in making the Ichnographie of this Figure you must include so many Squares as you think good within your outmost Square, all equidistant from and parallel to the outmost Square: And from one half of the Ichnographie produce the Scenographick Ground-plain for what Height and Distance you please.

Having therefore designed the Height *ab* of the first Step *bc*, Describe a parallel Scale, Thus, Draw a straight line from the Base to any convenient part of the Horizon, as here to *de*, then prolong the line *bc* into this line, as into *f*, then from the Visual point draw a line through *f* into the Base, as at *g*, and from the point *g* draw a line to the point *e* in the Horizon, Then transfer the distances *ah*, *ai*, and *ak* on the Diagonal line in the Scenographick Ichnographie to the Diagonal line *al* in the Structure, as to *ah*, *ai*, *ak*, and from those points on that Diagonal line raise the Perpendiculars *hmn*, *iop*, *kqr*, Then from the point *b* draw the Diagonal *bm*, and where that Diagonal *bm* cuts the Perpendicular *hm* shall be the bottom of the under Step *ms*, which Parallel line must be continued into *t*, for by drawing the Visual ray from *t* to the Visual point you will cut the line *de* in *v*, from whence

whence the line *vn* drawn parallel to the Horizon gives the top of the second Step: Then by drawing the Diagonal *no* you have the bottom of the third Step at *o*, from which point a Parallel drawn into *ge* and a Visual ray drawn from that point in *ge* shall cut *de*, from which intersection in *de* a Parallel drawn into *p* shall give the top of the third Step. The like you must do for the fourth Step. Then lastly, draw a Visual ray from the point *a* and a Diagonal from the point *x* to *y*, and where the foresaid Visual ray cuts this Diagonal erect a Perpendicular into the Visual ray *bz*, and from the point *z* draw a line parallel to the Horizon as far as the second Step, which shall shew how much of the hind part of the first Step will be seen. The same way you may find how much of the other Steps appear, as you may see in the Figure: for where the Diagonal *xy* cuts the several Visual raies, in those points the Perpendiculars erected into the Visual raies before, it shews how much of the hind part of each respective Step appears.

On these Steps you may place a Fountain; a Pyramid, or a Column, as is lately erected in *Corvent Garden* in the middle of the *Piatzo*.

This Parallel Scale is of great use, for by help of it you may set any Object in its true place, as well as with a Ground-plain of Squares: But you must remember to place your Perpendicular at the point of Distance, and so let it fall into the Base, for then by drawing a slope line from the point of Distance to any division of the Base, and by drawing a Diametral to the Perpendicular in the Base, where the Diametral cuts the slope line shall be the Height of the first parallel line of the Scale: and by drawing another Diametral to the point where the first Parallel cuts the Perpendicular the Diametral shall cut the slope line in a point through which a Parallel drawn shall be the second Parallel line, &c.

OPERATION XXXII.

How an Object that is to be placed high above the Horizontal line, shall be made that it appear equal to an Object placed but a little above the Horizontal line.

BEcause those Visual Raies that proceed from the Center of the Ey straight and directly forwards are more strong than those that decline towards the right or left hand, or are either elevated or depressed above or below the Horizontal line. Therefore any Object that stands at a convenient distance in the Horizontal line directly before the middle of the Ball of the Ey appears more perfect and true in shape and demension than if it were placed any where else; as may be proved by placing two Objects of the same shape and demension one in the Horizontal line just before you on a

Wall, and the other right above it at some considerable height on the same Wall; for you will find that the Object thus elevated will appear less than that which is placed on the Horizontal line: and that if the same Object be placed yet higher it will appear yet less and less. Therefore to know how big you shall make an Object for any given Height and Distance above the Horizontal line that it appear equal to an Object placed right before you in the Horizontal line, You must first consider, That as the Object that lies right before the middle of the Ball of the Ey in the Horizontal line appears most perfect, and by consequence shews its truest demension; So the Object that is placed higher or lower, or on the right or left hand appears less perfect, and by consequence requires a greater demension to make it appear perfect; for the Sight moving circularly in the Ey makes on a Wall the divisions of a Tangent line; and by so much as a Tangent increases upwards, in such proportion does the strength of the Optick faculty of the Ey diminish upwards. Therefore the Object that shall be placed any considerable height above the Horizontal line, and to be seen from a designed Station must exceed the Object placed just above the Horizontal line in such proportion as the Tangent of that Arch does the Tangent of the Arch just above the Horizontal line.

This Rule is very brief, and perhaps may not be understood by all Speculators in Perspective; Therefore I shall a little enlarge hereon, Because it is of eminent concernment in the true Seeing, Judging and making of Figures.

Having designed your Distance from the Wall; Set it off from the point your Ey is placed in; then set one foot of your Compasses in that point, and with the other describe the arch of a Circle, and divide it into so many equal parts as you please. So shall the raies that proceed from your Ey continued to the Wall shew on the Wall in what proportion the Object ought to increase to appear so large as an Object that is to be placed just before you on the Horizontal line.

For Example. Your Distance from the Wall is ab , Therefore at the point a describe the arch $1\ 2\ 3\ 4$ &c. which you may divide into so many equal parts as you please, and by laying a straight Ruler on the point a and on every one of those divisions, that straight Ruler will point out on the Wall or on the line bc which represents a Perpendicular line on the Wall the several sizes that an Object is to be of placed on those several Heights to make it appear equal to the Object placed just above the Horizontal line.

But that great Master *Albert Durer* hath very handsomly handled this Operation in an erected Pillar, wherein he hath made an Inscription in Letters, thereby demonstrating how much those Letters that stand high above the Ey must be made bigger than those that ly neer the Horizontal line: as you may see by this annexed Inscription.

Having thus performed the Operation you will see how much bigger the Letters far above the Ey are than those that ly neerer to the Ey. And this Rule is to be observed not only in the magnifying of Letters thus placed one above another, but also in magnifying of Figures

gures to be placed one above another on a Wall, be they either Painted or Carved.

OPERATION XXXIII.

To Describe in Perspective a pair of Winding Stairs.

Hitherto we have imagined the Glafs to be placed Perpendicular to the Base, and therefore as hath been said in CHAP. III. Those lines of a Figure that in a Geometrick Figure are Perpendiculars, are in the Scenographie also Perpendiculars; as here is seen in these winding Stairs; where because these Stairs should diminish upwards, the Glafs is placed Oblique to the Base. But to the matter.

This Geometrick Ichnographie is divided into sixteen equal parts, as 1 2 3 4 5, &c. which represents sixteen Steps that wind once about the Newel. Therefore reduce this Geometrick Ground-plain into Scenographie, as you were taught in *Operat. X.* by erecting Perpendiculars into the Base &c. and mark the Scenographick Ichnographie with the same Figures the Orthographick is; then on the middle of the Scenographick Ichnographie at the point 13 erect the Perpendicular 13 *a*, and divide it into so many equal parts as you please or intend to have Steps, and erect another line on the same point 13 into the point of deminution as 13 *b*: Then from every one of these divisions on the Perpendicular 13 *a* draw a Visual raie from the Visual point *c* to the line of deminution 13 *b*, and from the points where those Visual raies cut this line of deminution 13 *b*, draw Parallels to the Base into the middle of the Newel, and those Parallels shall shew the Distance or Height of every Step one above the other on the Newel. And for the Distance or Height of the further end of every Step you must erect a Perpendicular on the extream point of the Ichnographie as *de* of the same length your Newel is; and divide it into so many equal parts as you have Steps, or as your Newel is divided into unequal parts, as *fghik* &c. to *r*, and from the Visual point draw Visual raies through every one of them to intersect every respective line of deminution raised out of the Ichnographie so shall Parallels drawn from every intersection shew the height of the further end of every respective Step, as the first intersection is made on the first line of deminution *d 17* at *1*, therefore a Parallel drawn from the point *1* where the first Visual raie intersects the Parallel line *1*, shall shew the height of the further end of the first Step. The second Visual raie is drawn into the second line of deminution to the line *2*, therefore the Parallel drawn from that point shall shew the height of the further end of the second Step. The like is to be understood of all the other Steps.

Then for the length of every Step, instead of erecting a Perpendicular

cular on the several points of the Ichnographie to find them as you have been often taught before ; Draw severall lines from the point of deminution which is in the top of the Newel into every one of those divisions on the Ichnographie, and those lines of deminution shall bound every respective Step : As that raised out of the point 1 of the Ichnographie shall shew the length of the first Step. That raised out of the point 2 of the Ichnographie shews the length of the second Step : and so for all the rest.

OPERATION XXXIII.

Shewing the further process of the last Operation.

BEcause the multiplicity of lines in the last Figure may somewhat confound a Practitioner, here is inserted another Figure of a pair of winding Stairs, quite finishd, made by the Precepts of the last Operation. So that the lines that were in the last Figure incumbred with other lines appear naked here : and the places of the Shadows which there are troublesome to find out are here visible to the Ey. Herein (as before) you have two turnings about the Newel, and the whole Designe projecting forwards.

If you would have more turnings about the Newel, you must divide the two lines of deminution on each side into so many the more parts: As you were taught in the last Operation.

OPERATION XXXV.

The Description of a pair of Double Stairs, whereon two persons the one ascending the other descending shall not come at one another.

THese double Stairs are inserted as a peece of Rarity, and described only in Orthographie, and not by the strickt Rules of Perspective, lest with many lines the work should be obscured. Yet such as list to be curious therein may in the last (and several other) Operations find Rules whereby they may effect their purpose.

Describe a Circle (or which is equivalent a Semi-circle) for the Ichnographie, as 1 2 3 &c. to 13, and in it describe a smaller Circle, as *abc* for the bigness of the Newel: Then divide the great Semi-circle into twelve equal parts, as 1 2 3 to 13, and draw lines from those divisions into the Semi-circle made for the bigness of the Newel, so will that Semi-circle also be divided into twelve equal parts: Then on every one of the points in the great Semi-circle erect Perpendiculars, and those Perpendiculars shall shew the ends of each respective Step. As the Perpendicular at 11 bounds the outward end of the first

first Step: The Perpendicular at 2 2 bounds the second Step, &c. to 24. which makes good a whole Circle in the Ichnographie; and Perpendiculars erected from the inner Semi-circle marks, on the Newel the ends of the same Steps. Work the same way with the Steps on your right hand.

You may perceive that the winding of these Steps about the Newel may properly be compared to the winding of a thred about the Spindle of a Screw, And that as those Spindles that have but one thred winde not so suddenly about the Spindle as those that have two threds; So these Stairs having two Ascents, each begun Diametrically opposite to the other winde more suddenly about than those that have but one Ascent: and therefore it is requisite the whole Circle be divided into twenty four parts for these sort of Stairs, when as other Stairs have the Ichnographie divided but into twelve or sixteen equal parts.

The Newel is pierced through in several places only to let in Light.

Who was the first Inventer of these Stairs is not well known. But at *Scimburg* in *France* in the Kings Pallace is a pair of them, made by *Piedro del Bergo*, and *Iehan Cofin*. They are also set forth by *Vignola*, in his Book of Perspective, from whence this is taken.

OPERATION XXXVI

To Delineate in Perspective a Platform with Columns, Pilasters, Railes and Bannesters, as it is seen from above, where the Ey is placed directly over it at some reasonable height.

YOU were shewn in *Operat. XXVI.* that an Object placed far above the Ey deminishes. It is the same thing with an Object placed far below the Ey. For as you were told in *Chap. II. Defn. III.* The Visual raies do at last meet in a point: Therefore in this *Operat.* the Ey being placed above the Edifice, the upper Railes seem larger and wider than the under Railes, and the Bannesters under the upper Railes in *abcd* appear greater than the Bannesters in *efgh*, because the upper Railes and Bannesters ly neerer the Ey than the under, and so gradually the Object deminishes till you come to the Plat-form *iklm*, on which Plat-form you may note that the Square divisions being fifteen in length, and ten in breadth, are all equal among themselves, because the Glas is placed Parallel to the Horizon. And as you were told in *Chap. II. Defn. VI.* where the Glas is Parallel to the Horizon, all Objects on the Horizon have a true Orthographick appearance, but where the Glas is erected to cut the Horizon the Object seems a wry and shortens proportionable to the Angle the Glas makes with the Horizon, and so produces a Scenographick appearance. For, for this cause you have the Plat-form Or-

thographie, and the Structure thereon erected Scenographie; for as was said, the Plat-form lies parallel to the Glass, But the Structure is perpendicularly erected thereon.

This being rightly understood, you have already learnt the making this Edifice: For this Structure of Rails Bannesters Pilasters and Columns are erected on the four sides of the Base of the Plat-form by Visual raies drawn from the Visual point *n*.

Example of the whole. In the first place, That the upper Rail appears greater than the under, is (as was said) because it lies neerer the Ey: for if the Plat-form were elevated above the Pilasters the Squares thereon would appear as large as the Squares *opq*, and if the Plat-form were elevated above the Columns, the Squares would appear yet greater by so much as the Diametrals are wider asunder. And by consequence, if the Plat-form were elevated to the upper Rail (which is neere the Ey) the Squares would appear yet greater: But the Plat-form being so much farther off the Ey than the upper Rail, the Squares thereon draw neerer to the Visual point. Whence it also follows, that the Ranges of Bannesters in *efgh* appear less than the Ranges of Bannesters in *abcd*, But the Pilasters, Columns, Bannesters, &c. are all erected upon Visual raies, as you may see in the Figure.

OPERATION XXXVII.

Of designing the Geometrick Ichnographie of a Garden-plot into a Scenographick Ichnographie, in order to erect thereon the appearance of Arbors, Trees, Hedges, Fountains, &c.

THe Ichnographie here proposed is that of the Garden of the most Illustrious Prince of *Orange*, situate in the *Hague*, it contains in length 172 Geometrick Feet, and in breadth 91 Feet, marked *abcd*, having on the four angles four square Arbors marked *efgh*, as also four round Arbors marked *iklm*, with a Pavillion in the middle marked *n*, which Pavillion hath its entrance on four sides, viz. out of the two arched Galleries marked *op*, and the two long Walks marked *qr*. Within this Ground-plot is contained two Garden-plots with four Walks in each Garden, which divides them into four equal parts apeece, leading to the middle thereof, where stands two Fountains, as at *st*, encompassed with flower-pots, as also is the whole Garden between the outmost Walks and the Galleries: As you may see by the small round marks whereon they are to stand.

How to reduce this Geometrick Ichnographie into Scenographie you have often been taught in several foregoing Operations.

OPERATION XXXVIII.

To erect on the Scenographick Ichnographie the Fences, Arbors, Quick-setts, Fountains, &c. of the aforesaid Garden.

You have already the Scenographick Ichnographie laid down in the last *Operat.* To erect the foresaid appearances hereon you must raise Perpendiculars from the points whereon every particular thing is to stand, remembring as you were told in Chap. I. *Defn.* IX. that what ever lies right before the Ey is to be described Orthographically. viz. what ever is Parallel to the Horizon is to be drawn Parallel to the Horizontal line, what ever is Square is Square, or Round Round, as you may see in the fore Front of the Fabrick adjoyning to the Garden marked *a*, and the range of the fore and hind Wall. But if you behold any thing decline, from this Orthographick Front, though it be in the Fabrick a line Parallel to the Horizon, you are to draw it Scenographically, viz. from the Visual point, as you may see in the Walls that decline from the Front, making Angles therewith: and all the windows that you see in the foresaid Fabrick, how they do not ly Parallel to the Horizontal line, nor the side range of Columns on the one side, or Wall on the other: but all are drawn from the Visual point, as was said before.

This being considered the Operation proves easie, yet that this final Figure and all the curiosities appertaining to it may be the better understood, I shall explain the whole designe, which briefly is this.

In this Figure is somewhat more than the Plat-form of the last Figure described, viz. the Banquetting House, and the long Gallery, and also the Wall of the Dwelling House of his Highness the Prince of Orange Fronting the Garden. This Wall is marked *a a*, on the right hand of which as at *b* you have the said Banquetting House, and close adjoyning to it the said long Gallery, with Columns after the *Dorick* Order, containing sixteen Arches, and Turrets, with several Lanthorns on the top of it. On the left hand as at *c* is placed a Bridge leading over a Mote which incompasses the whole Building into a curious fair Walk, which Bridge is inclosed on both sides, and covered over on the top: Beyond this Walk is an high Wall beginning at the hither side of the Banquetting House, and going round the Garden to the farther side of the Banquetting House, within this Wall is another Walk round the Garden, and at the four corners of this Walk four curious square Arbors: and at the middle of the Walk is placed a Portal for the entrance into a long Gallery, which goes quite cross the whole Garden which Gallery is all covered with green boughs, so close that the light of the Sun cannot pierce between them. On either side and at the ends of this long Gallery stands a round Arbor,

also close covered with green boughs : within the Garden is erected on two Scenographick Circles two curious Fences of Quick-sett, with four entrances into each at opposite points in the Garden, which having four paths a peece leads to a curious Fountain set round about with Flower pots in the middle of the Garden.

Over three of the Arches of the long Gallery aforesaid is erected part of the said Banquetting House: of four more of the said Arches is made an Aviary well furnished with *Canary Birds*. And of the other nine Arches is made a Grott-work, with several curious delightful inventions of Water Works. Therest of the curiosities of this Peece may as well be understood by the Figure it self as by many words thereon.

OPERATION XXXIX.

To Describe in Perspective a Folding-chair a Frame chair, and a Bedsted.

HAVING designed the space in the Ground-plain that the Folding-chair shall stand upon, as here upon the Angles of four of the Squares, viz. *abcd*. That is, The distance of each foot is two Squares from the next foot; set off such an heighth from the Base as is proportionable to the length and bredth of the Chair: As here its heighth not being two Squares on the Base, viz. not so much as its length and bredth, the height wants somewhat of the Diagonal length of two Squares on the Base, which you must set off from the points *a* to *e*, *b* to *f*, *c* to *g*, and *d* to *h*, but you must note that for every foot you change your measure; for to the foot *a* that stands on the Base you take almost two of the Squares on the Base, to the feet *b d* that stands one Square above the Base, take almost two of those Squares, and for the last foot that stands neerest the Visual point, take almost two of the Squares in that place, so that the measure of each foots height be taken from that Square in the Ground-plain that each foot stands on, as is taught in *Operat. XVI*.

And because the Square of the seat of the Chair is broader than the Square space that the feet stands upon in the Ground-plain the sides of the Seat hangs over the sides of that Square. Therefore in this case you may erect a Perpendicular from the points *abcd* up to the Seat towards the point *efgh*, but you must draw the Seat somewhat beyond it according as in your discretion you find the Seat of the Chair hangs over the said Square, so have you the corners of the Seat *efgh*: and by a Diagonal line the height of the Back *ik*. The Rails in the Back, and the Rails between the feet are all drawn by Diagonal lines, as you may see in the Figure.

If you would have the Corners of this Folding-chair turned more or less towards you, you must draw an Ichnographic of it, as you are taught in *Operat. L*. and then you may turn the Corners of that

that Ichnography into what position you will against the Base, and by perpendiculars erected on the Angles of the Ichnographic, as you were taught in the foresaid *Operat.* the Corners of the Chair shall stand in their elected place.

The other Chair stands with its Foreside directly before the Ey, and is between the two Forefeet, two and an half Diagonal Squares, and between the side feet two Diagonal Squares, so that from these points in the Ground-plain the feet or posts of the Chair are made, by erecting Perpendiculars to your designed height, and then all the fore Rails of the Chair are Parallel to the Base and Horizon, and the Return or side Rails are Visual lines, as you may see in the Figure.

The Bedsted stands with its feet *a b* ranging directly forward, and is in length six Squares, and in breadth five Squares; so that the Posts are perpendicularly erected at this Distance to what Height you please: All the fore-Rails are parallels to the Base and Horizon, and the side-Rails are Visual lines, as in the fore-right Chair. Therefore this Operation is very easie, unless it be the Tester or Covering of the Bedsted; which because it is ridged at the top, and the fore and hind ends incline towards each other, may seem somewhat difficult. For designing of which, Find the middle between the two Posts *a b* in the Base, as at *c*, and draw the Visual line *dc*, and therein designe how much the Tester of the Bedsted shall fall away inwards from the upper Rail at the Feet, as from *c* to *e*; Therefore from the point *e* erect a Perpendicular to what convenient height you will above the upper Rail, as into the point *f*. and from the upper ends of the Post *a b* at the points *g h* draw straight lines into the point *f* for that part of the Frame of the Tester that belongs to the Foot end of the Bedsted. And to draw the hindmost slope of the Tester you may do thus: Make a parallel Scale, (as you were taught in *Operat.* XX. XI.) and on that Scale you may measure how much the angle *e* is erected above its Base, as here you will find a little more than one Square; therefore in the Ground-plain at the distance of a little more than one Square of that Parallel, under the line *i k* which is the bottom of the hind Feet, Draw an occult Parallel inwards within the Bedsted, because the Tester slopes inwards, as *m l*, and where that parallel cuts the Visual line *dec* shall be the angular point, as at *l*, and a Perpendicular erected on that point shall cut the Visual line drawn to the point *f* in the point *g*, which is the point that the hind part of the Frame of the Tester must be drawn unto from the two hind Posts. See the Figure.

These Posts are made square because the hind sides and corners of them may be represented by prickt lines, For in Frame-work it requires that one half of the Rails &c. be drawn from the hind sides and corners as well as from the fore sides and corners, which by the help of these prickt lines you are directed to.

OPERATION XL.

To describe two square Loggs unevenly laid one upon another.

THe nethermost angles of the under Log is imagined to ly towards the Base, and is marked with $abcd$, from which angles if you erect Perpendiculars into your designed Height as to efg , and from these points and angles draw Parallels from a to b , from c to d , from e to f , and from g to h ; and from the angles $abef$ Visual lines, you have the under Log inclosed; and its hidden Sides and Angles markt out: as you may see by the prickt lines gc and hd , and the angle c .

The other Log whose bottom is markt with $iklm$ lies athwart the first Log, with one of its angles against the Base, viz. the angle i : Therefore to set this Log upon the first Log you must erect Perpendiculars from these four angles, viz. from i to no , from k to pq , from l to rs , and from m to tv : Then draw Diagonals from the point x on the left hand to pn , qo , rt , and sv , and also Diagonals from the point y on the right hand to the points qs , ov , pr , and nt ; and by erecting Perpendiculars from p to q , n to o , r to s , and t to v , the Log is inclosed.

OPERATION XLI.

To describe in Perspective a Form, a Table, and an Andiron &c.

THe Form stands with its ends before the Ey upon the width of two Diagonal Squares on the Ground-plain, as ab , and in length ten Diagonal Squares, as 12345678910 .

You may make the Form of what height you please, as you may see by the Perpendiculars marked ac , bd , on the Seat of the Form. The Seat projects or hangs over the Form half a Diagonal Square on each side and end, therefore you must draw an occult Parallel at the distance of half a Diagonal Square within the Base on the Ground-plain as ee and ff , and two occult Diametrals at the distance of half a Diagonal Square on the Base from the Perpendiculars ac and bd inwards, as gb , which must be prolonged to the hind end of the Form; and where these Visual lines cut the Parallels shall be the outward bounds of the four Feet in the Ground-plain, which must be erected perpendicularly into the Seat. The fore and hind Rails of this Frame are Parallels, and the side Rails are Visual lines.

The Table on the left hand is placed with its corners against the Ey, and stands in length upon ten Diagonal Squares, and in breadth upon six; of which the Leaf of the Table projects over its Frame one Square on each

each side and end: The side lines for the Rails and the Leaf are drawn from the point of Distance *a* on the right hand, and the end lines for the Rails and Leaf from the point of Distance *a* on the left hand; and the Posts of the Frame stand each upon one Square, and are all perpendiculars erected into the Leaf: So that here remains nothing of difficulty in this Figure, unless it be the projecting of the Leaf over the Frame, which though it be performed after the same manner of that on the Form, yet because the Table stands not in the same Sight the Form does, I shall explain this also.

The Leaf of this Table hangs perpendicularly over ten Squares one way, and six another, in the Ground-plain; and this Square projects over the Frame one Square on each side, as hath been said: Therefore find the lines in the Ground-plain that include the ten Squares, viz. *b6* and *10c*, and by taking away one row of Squares on every side the Ground-plain, you will have eight left one way and four another, which is the bounds and gives the sides and angles the Frame stands on. So that you see though this projecture seem difficult it is easily performed on the Ground-plain.

If you would place any thing on the Table at a Designed Distance from either side and end on the Table (as below, which is the same with this, only that is shadowed, that the lineaments may appear the plainer :) For instance upon the edge of the hithermost side of the Table within six inches of the hither end, you would place the Candlestick; Then imagine the Table to be four foot long, and three foot broad, so shall each Square on the Ground-plain of the Table represent six inches. Therefore count to the end of the first Square as to the point *1*, and there erect a Perpendicular, and where that Perpendicular cuts the edge of the Table shall be the place of the Candlestick. Again, If you would place the hither edge of the Bottom of the Beker within two foot three inches of the hither end of the Table, and within one foot of the hither edge of the side of the Table, then count in the row of figures that runs up on the right hand *1 2 3 4* and half one more in the Ground-plain which is two foot three inches, and from that point erect a Perpendicular into the Leaf of the Table: then count in the line of figures that runs down on the left hand from the point *6* to *4* which is one foot and erect a Perpendicular from that point up to the edge of the Table and draw a Diagonal from that point and the point *a* on the right hand, and where that intersects the Perpendicular erected on the point of *4* ¹/₂ shall be the point where the middle of the hither edge of the Beker shall stand. If you would in-compass that point in the ends of the Legs of the Table which appear through the Leaf, you may work as follows in this next example.

Count from the point *b* to the point *1*, which is one Square of the Ground-plain, and the point where one Angle of the Leg is placed, and from that point *1* erect a Perpendicular into the side of the Leaf of the Table, as at *1*, and from the line *a* on the left hand draw a line to that point for the bounds of the fore side of the two fore Legs: Then because the Legs are one Square, viz. six inches every way, erect ano-

ther Perpendicular on the point 2 to the point 2 on the edge of the Leaf, and to that point draw another line from the point *a* on the left hand, and that line shall bound the hind side of the fore Legs; Then erect Perpendiculars from the angles of the Legs; And to the points where these Perpendiculars cut the former lines draw other lines from the point *a* on the right hand; and the lines drawn from the points *aa* on either hand shall bound the top of the Legs: As you may see in the Figure. Do the like when you describe the hind Legs.

OPERATION XLII.

To describe a Press with its corners towards the Ey.

THis Press is placed on a Ground-plain of Diagonal Squares; made as by Operat. XVI. with its angles towards the Base. Its undermost Planck contains eleven Squares in length and nine in breadth, and projects over its Frame on every side one Square: so that the Frame stands upon nine Squares in length and seven in breadth, and in thickness one Square. These Legs are to be erected perpendicularly up into the under Planck of the Press, as the Legs of the fore-going Table were into the Leaf: And this Planck is also made as the Leaf in the fore-going Table. The lines representing the sides of the Plancks, the Rails in the Frame &c. are all drawn from the two points of Distance *aa* on the right and left hand, as you have already been taught.

For placing the Screw in the middle of the upper Planck, Draw from the four angles of the upper Planck *b c d e* two Diagonal lines, and where they cross each other is the middle point of the Planck, in which the Toe of the Screw is to be fitted. This Screw is erected perpendicularly into the Rail wherein the Nut is made. The Cheeks *ff, gg*, contain each one Square, and are also perpendicularly erected.

OPERATION XLIII.

To describe a Frame with four Posts and three Shelves therein, a Chair, a Door, a Thorow-fare, and two Holes in a Wall.

THis Frame stands with its angles against the Base upon seven Squares one way, and six the other. It is Railed round the bottom, and hath one Shelf below the Horizon and two above it. The manner of making it hath sufficiently been taught in the foregoing Operat. viz. The Posts are Perpendiculars erected on the Ground-plain; and the Rails, Shelves, &c. are all drawn from the points of Distance *aa* on the right and left hand. The Shelves you must note do not project over, but run range with the out sides of the upright Posts.

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The Chair contains in the bottom four Squares each way, as you may see in the Ground-plain. The making the Chair hath already been taught in *Operat.* XXXV. Only the sight of this Chair is changed, for the Legs are placed against the Base. For finding the middle of the Back of the Chair, in order to making the peak in the upper Rail behind, draw from the points *bc* and *de* two lines, and where they cross each other, draw a Perpendicular through the whole Back of the Chair, and that Perpendicular shall be the middle between the Back posts of the Chair, to which point you must draw up the Peak.

On the left hand you have the Frame of a Door described standing on four Squares in the Ground-plain. The thickness of the Frame is one of those Squares: It is easie to be understood by the Figure alone.

Above the Frame of the Door you have a four-square Hole described, with one of its Angles downwards, which is two Squares high and two Squares broad: Therefore from the point 2 in the Ground-plain erect a Perpendicular, and on that Perpendicular designe what height the lower Angle of the Hole shall stand at above the Door, as here at *f*, then draw a Visual line through the point *f* into the said line of the Figure as to *g*, and from the point *g* set off four divisions of the Base upwards, as 1 2 3 4, and draw another Visual line through the Perpendicular into the point 4, and where the Visual line cuts the Perpendicular, as here at *h*, shall be the upper Angle of the Square Hole; Then erect two Perpendiculars one from the point *o*, the other from the point 4 in the Ground-plain, and where these Perpendiculars cut the Visual line *iz*, as here in the points *kl*, shall be the other two opposite Angular points of the square Hole; and straight lines drawn from *f* to *h*, from *h* to *b*, from *b* to *k*, and from *k* to *f*, shall include the fore-side of this square Hole. The back side may be easily apprehended by the prickd lines behind the Figure. If you would find the middle of this square Hole, draw lines from each two opposite Angles, as from *f* to *b*, and from *k* to *h*, and where they cut each other shall be the middle of the Hole.

On the right hand over a thorow-fare is described another square Hole, with one of its sides downwards, containing also two Squares on each side. To make this, erect a Perpendicular on the point 2 in the Ground-plain on your right hand, and on that Perpendicular designe the height of the under side of your Hole, as at *m*, and through that point *m* draw a Visual line into the side-line as at *o*, from which point *o* set off two divisions (as afore said) of the Base upwards, as at *o 2*, then erect another Perpendicular as at *o* in the Ground-plain through the Visual line, at the point *n*, and so much of the Visual line as is contained between the points *mn* shall be the under side of the square Hole; then draw another Visual line from the point 2 on the side-line, and so much of that Visual line as is contained between the two Perpendiculars *on p* and *2 m q*, viz. *p q* shall be the upper side of the Hole. The other two sides are the Perpendiculars *p m* and *q m*: By the Parallels *q r*, *m s*, *p t*, and *n v*, you have the thickness of the said Hole, viz. one Square, as in the Ground.

OPERATION XLIIII. XLV.

To Delineate the Scenographick Plat-form of Buildings, in order to the true Describing of Houses, or other Buildings in Landskips.

THis Geometrick Ground-plot is reduced to Scenographie by the Rules you were taught in several foregoing *Operations*; whether I refer you. But if it be required that you make the Ceiling of the same form the Ground-plot is, you must erect Perpendiculars to your designed Height from the several Angles of the Scenographick Ground-plot, and Visual raies drawn from the point *a* by the interfection of Diagonals drawn from the points *b b* shall inscribe the Roof or Ceiling also, (as you were taught in *Operat. XXV. XXVI. XXVII. &c.*

It will in some Cases be convenient to take the lines *cc* or *dd* for the Base; and then you will have the Ground-plot and Ceiling for the sides: By which means you may easily make Holes through Walls, or describe Loggs lying crosse one another, &c.

OPERATION XLVI.

To erect a Building on the first Ichnographie of the former Leaf.

THe former Ichnographies are described in this Plate: And what is hid by the Structure raised thereon is marked with prickt lines, as you may see the Scenographick Squares marked 1 2 3 4 5, in Fig. XLII. whereon the four Pavilions and the Steeple are perpendicularly erected to a convenient height. Here you may see that Ranges on the fore-right sides are parallels to the Base and Horizon, and the Ranges on the right angled Return sides are drawn from the Visual point: and the cut off angles (which we must also call sides) are drawn from the points of Distance. As in the Octangular Structure, *Operat. XXVII.*

OPERATION XLVII.

To erect a Building on the second Ichnographie of the former Leaf.

THis Pyramidal Spire stands upon four Pedestals, and hath the middle of its top found in the Ichnographie, as at *b*, by erecting a Perpendicular from that point: and the rest of its sides are made by erecting Perpendiculars into the surface of the

the Pedestal, and from thence carried up towards the top of the Spire. The shortning both of the Sides of the Pedestal and Spire are drawn from the Visual point. As you may see in the Figure.

OPERATION XLVIII.

To delineate the appearance of Buildings, in order to the truer drawing of Landskips.

BEfore we treat of Landskips it will be necessary to begin with Houses in several positions, viz. with their Sides in Orthographie, and Front in Scenographie: As the Figures A C D: And with the Front in Orthographie, and Sides in Scenographie: As the Figure B, and several others already described in this Book represent: with the several appendices belonging to Houses, as Steps, at *a*; Penthouses, at *b*; opened Windows, as at *c*; Jetties, as at *d*; Buttresses, as at *e*; Bridges, as at *f*; &c, all which may meely by considering the prickt lines, and whence they proceed, be understood. As for Example. To find the middle Perpendicular line of the Front in Fig. A. in order to the ridge of the Front in the middle, as at *g*: Continue the Perpendiculars *h h* and *i i* to a convenient height, and draw two Visual raies at what distance you please through them, as here the Visual raies *i* and *k*, and from the points where the Visual raies cut the Perpendiculars, draw two straight lines corner-wise, as *h k*, *l i*; and the intersection of these two lines shall be the middle of the Front between the two Sides, and a Perpendicular erected on that intersection through the top of the Front shall be the line the Ridge must be placed in: as is shewn by the Figure. The arch of the Bridge at *f* is drawn from the two centers *m n*.

The finding the middle line in the House C is otherwise performed, for this House is covered with a Spire whose four sides falls into the middle of its Ichnographie; Therefore to place it right you must have the middle of the Ichnographie it stands upon: as here, the sides *o q*, *q r*, *r p*, *p o*, for then lines drawn from the two cross corners shall intersect each other in the middle of the Ichnographie, and a Perpendicular erected shall shew the middle of the Spire, as at *s*; And straight lines drawn from the top corners of the Building shall inclose the Spire.

But if you will have a Ridge-cover to this Building, the Ridge must ly in the middle of the Orthographie, as here at *t v*, and straight lines drawn from the two Orthogtaphick sides *o p* to the point *t* shall make the fore-point of the Ridge.

Here is also a Draw-Bridge described, where the prickt arch *xy* shews the arch it describes in drawing up. But all the Scenographie of this Projection being made from the Visual point, become so easie that I need make no more words on it.

These Structures are placed just on the surface of a Water, Because a flat Ground should appear about them. The Scituation of the Figure may be easily understood by the Visual point, and point of Distance *z*.

OPERATION XLIX.

Of Landskips in general: How they must be ordered.

IN the first place you are to observe for a Rule, That if in your Landskip you have any standing Water (as a River, a Pond, &c. to describe, you place your Horizontal line level with the farthest sight or appearance of it; as in this Figure: where the Visual point placed in the Horizon is at *a* in the Water.

2. If any Houses or Cottages happen in your Picture, you well consider their position, that you may the better find from what point in the Horizontal line to draw the Front and Sides of those Houses, &c. As you shall be taught in the next Operation.

3. That when you describe any thing at a great distance, you make it rather too big than too little, that you may the better accommodate your Picture to the sight and understanding of the Vulgar.

4. For Trees, Hedges, Shrubs, &c. you are left to your discretion, for making them either slender or stubbed, thick or thin of Leaves, &c. because it would be endless in drawing them by proportion; partly for the multiplicity of parts in every Tree, &c. and partly because the season of the year alters their appearance.

5. In Colouring and shadowing, Those Objects that ly neer the Ey, you are to make of the same Couloure in your Picture they are in the Object: only as they run from the Ey they must be made fainter and fainter, till at last they all loose themselves in a dark Sky Couloure.

OPERATION L.

To draw Buildings that are posited obliquely to the Horizontal line.

PLace your Geometrick Ichnographie in what position you think good, as here *A B C D*, which reduce to Scenographie, as by many of the foregoing *Operations*, and as here you find them at *a b c d*, then on the corners of these Scenographick Ichnographies erect Perpendiculars for the several corners of your Buildings, as in *Figure A* erect the Perpendiculars *A a, b c*, and draw a line through the points *A b* into the Horizon, as at *d*, for the Ground-line of that side of that House, so shall all lines that are on that side of that House Parallel to the Ground-line be drawn from that point *d*; as the lines *a c* and *a f*: thus the Return sides of *A b* must be drawn from the point *g* in the Horizontal line, whether (as you may see) the lines of the Ichnographie tend. The like you find in the *Figures B C D*, where in the *Figure B* two sides appear. viz. the sides *B b* and *B i*: from *B b* the line *B b k* draws the Ground-line on the left hand,

hand, and *Bi* the Ground-line on the right hand. In the House *C* the Return sides are drawn from the point *n* in the Horizontal line. And for the House *D*, the lines *Do* and *Dp* prolonged into the Horizontal line, as at *qr*, delineates those sides, and all lines that in the Structure are Parallel to those sides: as you may see in the lines *rr* &c.

OPERATION LI.

Shewing how to represent Shadows of Bodies.

Shadows are made by the position of Opacous Bodies before Luminous Bodies, which Opacous Bodies stop and hinder those Lines of Light which else would pass from the Body of Light to the Plain whereon the Opacous Body stands.

By Lines of Light, I mean those straight lines that pass from the Body of Light to the Plain. Thus the line *ab* is a Line of Light.

These Lines of Light, the Plain or Line of Shadows, and a Perpendicular let fall from the Body of Light makes alwaies a Triangle, as is the Triangle *abc*, where *ab* represents the Line of Light *c* *b* the Plain or Ground-line of Shadows, and *ac* the Perpendicular.

If in this Triangle any Opacous Body be placed so as to break the lines of Light, that opacous causes a Shadow: Thus the Staf *de* erected perpendicularly at *d* breaks all the lines of Light inclosed between *deb*, and makes the Shadow *db*: by which instance alone you may see the manner and properties of Lines of Light; and how a straight line drawn from the line of Shadows through the point the Opacous body stands on, and a line of Light drawn from the body of Light through the top-point of that opacous body shall cut each other in the point of termination of Shadow. By this proposed Staf I would have you understand a Line, though in this place it would be unproper to call it so, because that having no Geometrick breadth makes no shadow. But as was said in the third Operation, where a Line was laid down in Perspective, knowing how to draw a Line in Perspective you know how to draw all Figures, because they are bounded by Lines; so I may say in Shadows, for though the Object be a Body, yet the Shadow is but a Figure, and by knowing how to draw the Shadow of every Line properly you know how to draw the whole figure of Shadow. As you may see in this next Operation.

OPERATION LII.

To find the Shadow of a Cube, the elevation of Light above the Ground-point being assigned.

The given Light is *a*, the Ground-point *b*, the Cube *cdefghik*. Therefore from the upper angles of the Cube *cdef*, I draw lines of Light through the Plain, and from the point *b* I draw lines of Shadow through the under angles of the Cube, as

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through

through $ghik$, and where these lines of Shadow cut the lines of Light (as here ac cuts bi in l , ad cuts bh in m , af cuts bk in n) shall be the points that the shadowing angles of this Cube casts its shadow on the Plain, as here to lmn , and straight lines drawn from m to l , from l to n , from n to k , and from m to the side of the Cube gc shall include the shadow.

OPERATION LIII.

To find the shadow of a Cilinder, the elevation of the Light above the Plain of shadow being given.

THe Body of Light is a , the Ground-point b , the Cilinder $cdef$, $ghik$: The Cilindrick section above the plain of Shadows you must bring into the Plain of Shadows, by letting fall Perpendiculars from the four divisions above, viz. $cdef$, into the plain of Shadow, as at $lmno$: Then by drawing lines from the body of Light through the divisions in the upper end of the Cilinder, as through $cdef$, and from the points g through l , k through o , through n , and b through m ; where the lines of Light cut the lines of Shadow, as here in the points pqr , shall be the bounds of a Scenographick arch, which joyned to the straight lines hp and kr shall include the shadow.

You must note, That the Scenographick Figures $cdef$, made at the top of this Cilinder, and $lmno$, made by the Perpendiculars let fall into the Ground are true Scenographick Circles; and that the circle $cdef$ appears smaller than the Circle $lmno$, because it is posited neerer the Horizontal line, which alters the Scenographick appearance: as you may see in the several Circles that are made about the Newel of the Winding Stairs, in Operat. XXXIII. This I mind you of, because from the divisions in that Circle, and not from the Ground-point, the lines of Shadow are drawn to cut the lines of Light.

OPERATION LIIII.

To find the shadow of a Cone set on its point, the elevation of Light being given.

THe Body of Light is a , The Ground-point b , the Cone $cdefg$, Project the top of this Cone (which is a Circle) Scenographically, as in Operat. IX. X. and by Perpendiculars let fall on the Ground, draw also the other Circle $hikl$ from the same Visual point, and point of Distance: Then from the Body of Light draw lines into the Ground, through the points $defg$ of the upper Circle, and from the Ground point draw lines through the points $hikl$, in the Circle on the Ground; and where these lines intersect each other, as here in the points mno , shall be the points through which the Scenographick arch mno drawn to meet the straight lines im , ln , and ko , shall be the track that shall include the shadow.

OPERATION LV.

To find the Shadow of a Tetrahedron with one of its points set on the Ground, the elevation of Light being assigned.

THe given Light is *a*, the Ground-point *b*, the angles of the Tetrahedron *cde*; Project the Triangle *cde* Scenographically on the Ground, by Perpendiculars let fall from the angles, as into *ghi*, and let the length of the Perpendicular *ef* be the length of the Side *cd*; so shall the sides *gh*, and *hi*, be drawn from the same point in the Horizontal line that the lines *ce* and *ed* were drawn from. Then from the body of Light draw lines into the Ground, through the points *cde*; and from the Ground-point draw lines through the points *ghi*; and where these lines intersect each other, as here in the points *klm*, draw straight lines from *f* to *k*, from *k* to *l*, and from *l* to the side *df* of the Tetrahedron, where it is cut by the prick line *mn*.

OPERATION LVI.

To find the Shadow of a Staff broken by the interposition of a Parallelepipedon, and by the interposition of a Cilinder. The Elevation of Light being assigned.

THe Body of Light is *a*, the Ground-point *b*, the Staff *c*, by working as by Operat. LI. you find a straight shadow continued from *d* *e*, where the shadow breaks against the Parallelepipedon, and rises Perpendicularly on the side *ef*, and thence on the upper side of the Parallelepipedon continues it self Parallel to the Plain of Shadows as at *g*, and so loses it self behind the further side of the Parallelepipedon.

But the Staff *hi* makes another fashioned Shadow on the surface of a Cilinder; for by working as before, you find the shadow of the Staff continue straight from *i* to *m*, where the interposition of the Cilinder breaks the shadow, by receiving it on its own surface in the form of a Scenographick Semi-circle, which is the Figure the Circumference of this Cilinder would make, if it were cut asunder in *mn*.

OPERATION LVII.

To draw a Figure which on the Plain shall be deformed: yet when seen from a designed point through a Hole shall shew a Comely and proportionable shape.

Make a Plain of so many equal parts as you please, as is the first Plain $ABCD$, which is devided into 8 in length, and 8 in depth, as you may see markt down the side and bottom with 1 2 3 to 8, and therein draw what you think good: as in the second Plain $ABCD$. Then make an other Plain of as many unequal parts as is the third Plain $cadb$, (and mark two sides of that also with 1 2 3 to 8.) Thus, Set off one side of your first Plain $ABCD$ at db of the third Plain, and in the middle of it as at e , erect a Perpendicular as at e 4 f , which point f shall be the point of Distance: from this point of Distance draw two straight lines as fc d , and fab : then set off your intended height from the point of Distance, as fg , and draw the Diagonal line gcb to the point b , and where this Diagonal cuts the out line fc d , as here at c , draw the line ca Parallel to db , so is the four sides of your third Plain made. To divide this into small squares as your first Plain is, do thus, Devide the line db into 8 equal parts, as 1 2 3 to 8: then lay a straight Ruler to the point of Distance f , and to every one of these divisions successively, and by the side of it draw lines from the line ca to these divisions, and these lines shall represent the Perpendiculars in the first Plain: Then from the points where these Perpendiculars cut the Diagonal gcb draw lines Parallel to the lines ca and db , and these lines shall represent the thwart lines that cut the Perpendiculars in the first Plain.

Having thus projected your Plain, drawn therein the figure that was drawn in your second Plain; and be carefull to draw every stroak thereof in its responding Square and part of the Square, with the same proportion to each of these Squares that you find in the squares of the second Plain. And though the figure seem when drawn very distorted and unproportionable, as in the fourth Plain $abcd$, yet if you place one of your Eys directly over the point far the height of the line fg , and winck with the other Ey, you shall see (if your figure be exactly drawn) the perfect shape of the figure in the second Plain. But that you may the better understand me I have pasted a thin Past-board on the line hfg , which if you erect perpendicularly, and look through the hole with one of your Eys close to that hole, you may see the same figure in this fourth Plain that is drawn in the second.

OPERATION. LVIII.

To draw on a Quadrant a Figure seemingly confused and without Design, yet when of this Quadrant a Cone shall be made, a comely and proportionable Figure shall appear.

DEscribe a Circle of the bigness you intend the Base of your Cone shall be, as the little Circle 1 2 3 4 &c. to 8. Devide this Circle into so many equal parts as you will (the more the better) this is divided into eight: and from the Center draw straight lines to every one of these divisions, as to 1 2 3. &c. to 8. Then devide one of these Semi-diameters also into eight equal parts, and through every one of those equal parts describe on the Center a circle concentrick to the outmost, as the Circles 1 2 3 to 8. Then to make the appearance of these Lines and Circles on the outside of a Cone, Describe a Quadrant whose Radius shall be twice the Diameter of this Circle, as the Quadrant on the right hand, and continue the under Radius to an extream length. Devide this Quadrant into two equal parts, and devide the lower part into eight equal parts; then erect a Perpendicular on the Base as at 8, and from the Center draw straight lines through the eight divisions aforesaid into the erected Perpendicular. Then placing one foot of your Compasses in the point 8, open the other successively to all the intersected points in the Perpendicular, and describe the several arches 1 7, 2 6, 3 5, 4 4, 5 3, 6 2, 7 1, 8 0. Then devide the outmost arch into eight equal parts, as 1 2 3 4 5 6 7 8, and draw straight lines from the Center into each of these equal parts; So shall this Quadrant when cut close by the outmost lines thereof, and rolled up in the form of a Cone, and placed directly before the Ey, so as the light may fall round about it, shew like the little Plain of Circles and straight lines, and be of the same bigness, and all the arches in this Quadrant shall become concentrick circles equi-distant from one another: and the straight lines shall proceed from the center both waies into the circumference.

Whence (by consequence) it will follow, that what lines soever are drawn in any of the squares of the Plain of Circles, and the same transferred to the Quadrant, in the square responding to that square in the Circle, it must also appear in the Quadrant, when made in a Cone, in the same shape it doth in the Circle, As you may see in the enlarged Circle and Quadrant, wherein a Figure is delineated.

Of Catoptricks or Reflected Beams.

REflected Beams are seen in a Glass, or other matter curiously polliht. If this Glass or polliht matter be exactly flat the Object appearing in it, is exactly like its Original. This you see in common Looking Glasses: But if the Glass be not
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flat

flat the Object alters from the Original, and that more or less according as the Glass is more or less flat, Therefore in drawing Catoptrick Figures you must consider the Shape of the surface of the Glass which you intend to have the Reflection made upon, and for every surface you must make a particular Ichnographical Projection, which must on the Glass appear to be a Plain full of equal Squares: on which Projection if you transfer what shall be drawn on a Plain divided into the same number of true Squares, though in the Projection it shall shew very distorted and confused; yet shall the Reflection thereof on the Glass shew very regular, proportionable, and well composed. I shall give you one Example thereof in this next Operation.

OPERATION LIX.

To Draw an Appearance seemingly confused and without designe which shall Reflect on a Cilinder Perpendicularly erected in a designed place, an intended Figure.

Suppose (For Example sake) it be the likeness of the Figure A that is intended to be seen Reflected on a Cilinder. First divide every side of the Figure into so many equal parts as you please (here we will take 12) and draw lines through these divisions to cut each other at right Angles. Then if you make a Projection whose Reflection on a Cilinder shall shew the same shape and number of Squares: It follows by consequence that if you transfer all the Lineaments in the Figure, A to this Projection, and place every Lineament in its proper situation so as to correspond with the same space from the top and sides of this Plain, every one of these Lineaments in the Projection shall also appear in the Cilinder in the same shape and situation they do in the Square Plain.

Therefore to make this Projection, describe on the Center *a* the Circle *bacd*, of the same Diameter you intend the Cilinder shall be, suppose about an Inch and an half; divide the Semidiameter of this Circle into 4 equal parts, as 1 2 3 4, then on the division at 3 place one foot of your Compasses and extend the other to what width you intend your outmost Circle should be, as here to *e*, and describe the Circle *feg*: Then divide one of those parts of the square Plain into 20 equal parts or sub-divisions, and make the first division from *e*, 6 of those equal parts or sub-divisions bigger than one Square, which you must set off on the Diametral line from *e* towards *a*: the second from *e*, 5 of those sub-divisions bigger than a Square which also set off from *e* towards *a*, the third 4, the fourth 3, the fifth 2, the sixth 1, and the seventh equal: the eighth 1 sub-division less than a Square, the ninth 2 less, the tenth 3, the eleventh 4, the twelfth 5 sub-divisions less than a Square, which successively set off from *e* towards *a*: then on the Center

Center at 3 (aforesaid) place one foot of your Compasses and extend the other successively to each of the divisions set off on the Diametral line, and through every one of those divisions describe so much of a Circle as the Plain will bear, so shall all these arches of Circles represent those straight lines in the Plain square A that run athwart the Plain from the left hand to the right, and reflected on the Cilinder they shall become straight lines parallel to each other.

To represent in this Projection the Perpendiculars on the Plain square, you may on the Center *a* describe an occult Circle as large as you can within the Projection, as the Circle *bikl*, divide half of this Circle as *kgb* into 8 equal parts, and through every one of these equal parts draw lines from the Center *a* into the Circumference of the Projection, and these lines shall represent 8 Perpendiculars on the Plain square. To draw the other 4 transfer the distance of one of the divisions in the Circle *bikl* twice from *l* towards *k*, and twice from *i* towards *k*, and draw straight lines (as before) through these distances into the Circumference of the Projection: so shall the whole Projection be finisht.

Note that in this Projection the whole Circle is not divided into 12 equal parts, but only three quarters thereof, because the Cilinder will not well gather in more raies, for the other quarter lies hid behind the Cilinder.

Of Dioptricks or Broken Beams.

THe Broken beam is to be seen in a Tube, through a Chrystal or Glas that hath its surface cut into many Faces: as is the Fig. A: for every one of these Faces making Angles with the Base or Flat side of the Chrystal shew an Object each as through its own Face and not through the Flat of the Chrystal: And so is said to break the Raies of an Object: because to the Flat of the Chrystal the Raies run straight, but afterwards they break into the same Angle the Face on the other side of the Flat makes with the Flat.

Thus it comes to pass that when these Faces on the Chrystal are turned towards a Plain placed directly before it, these Faces of the Chrystal dis-sever themselves at a considerable distance on the Plain, because they are all directed to several remote parts of that Plain.

Now though there hath not as yet been any Geometrick Rule found for the assigning a place on the Plain of each of these Faces, yet is there found how they may be placed on a Plain; as you shall learn by the next Operation.

OPERATION LX.

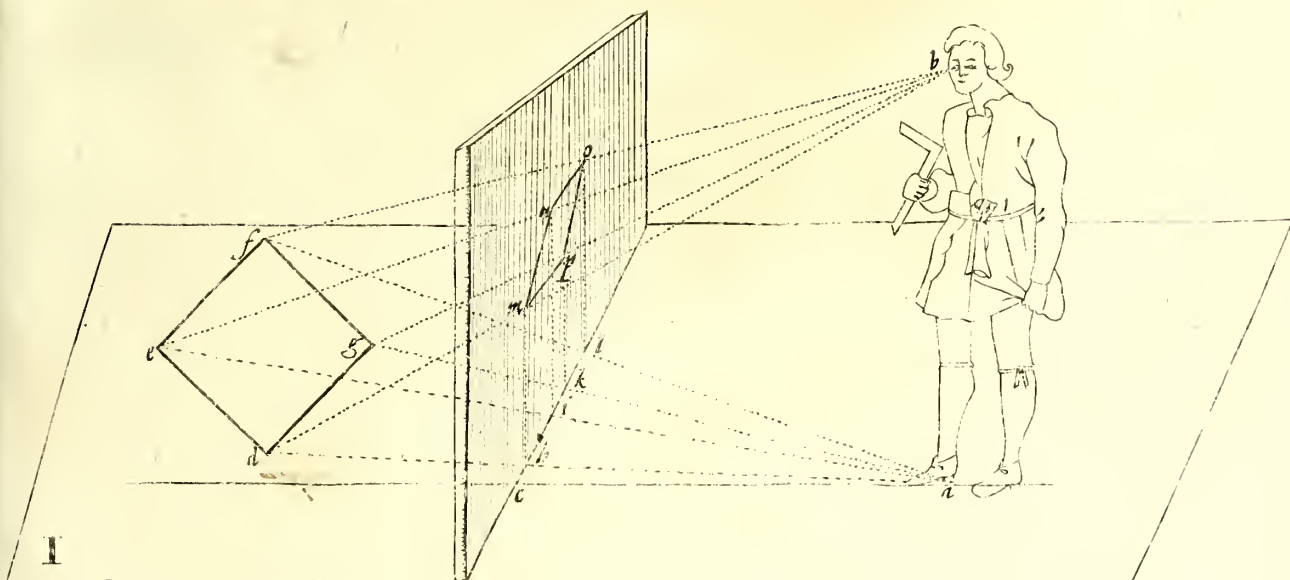
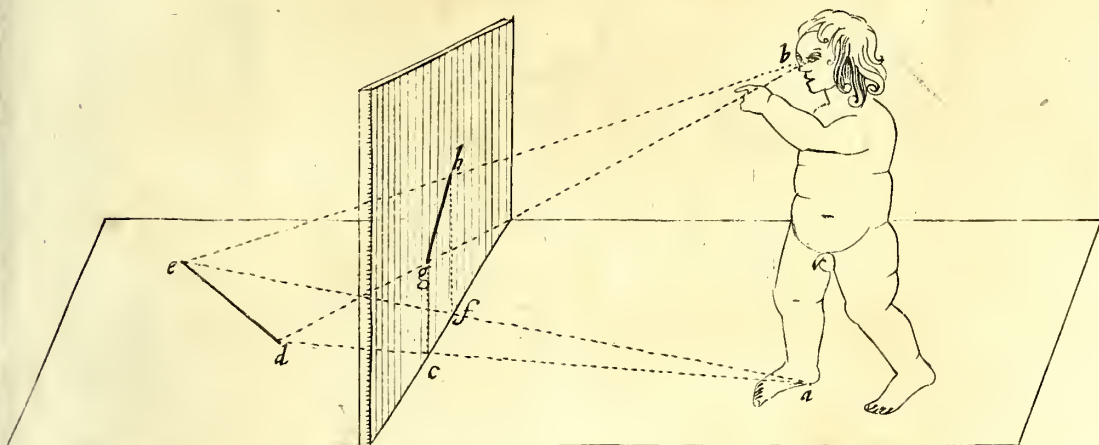
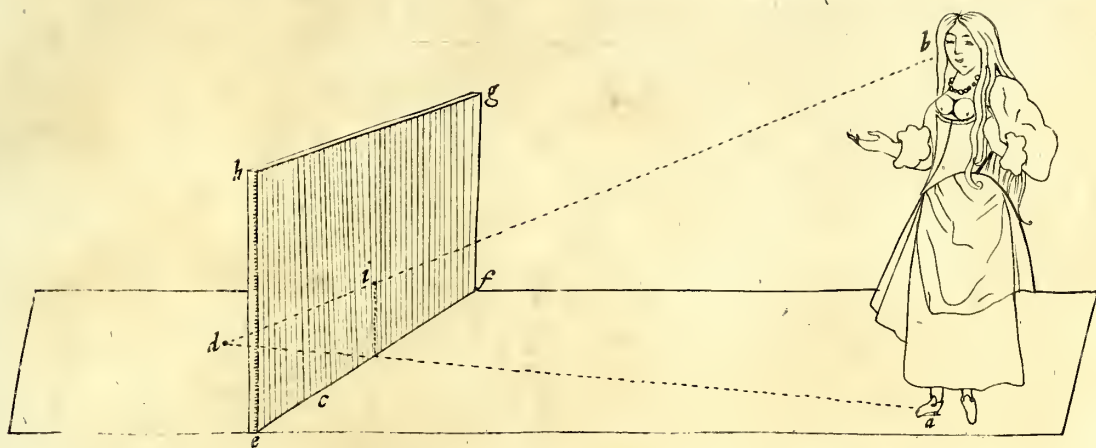
How among a great many Pictures on the Plain, to see one elected and peculiar Picture quite different from any on the Plain.

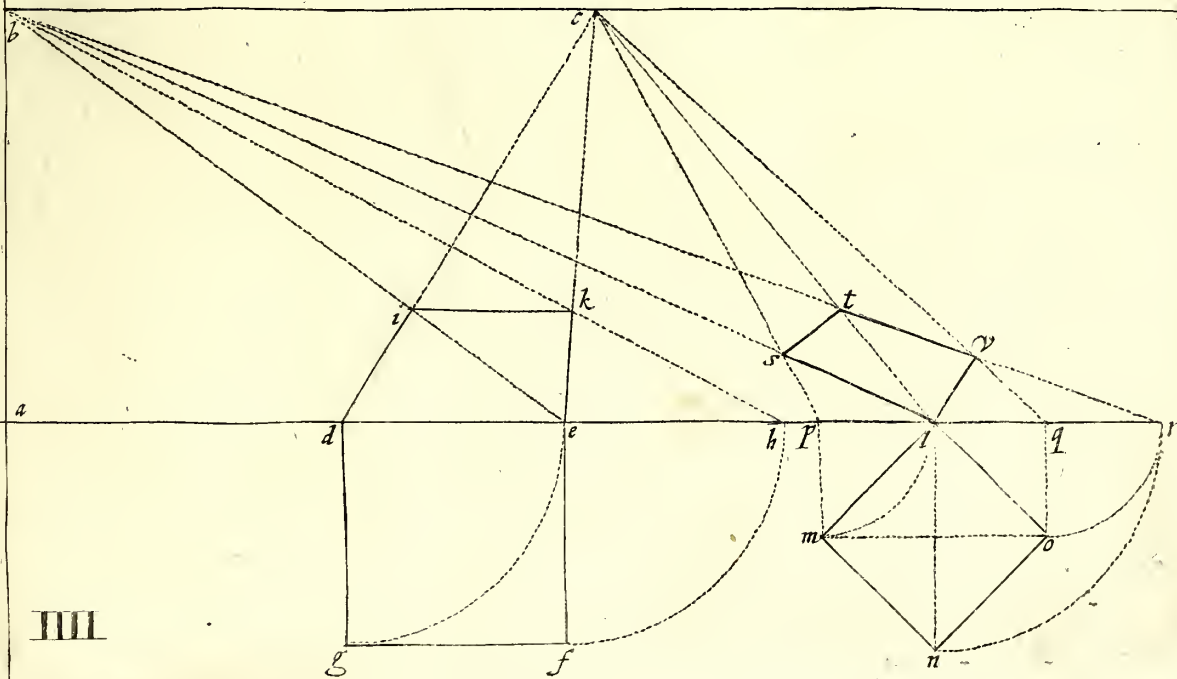
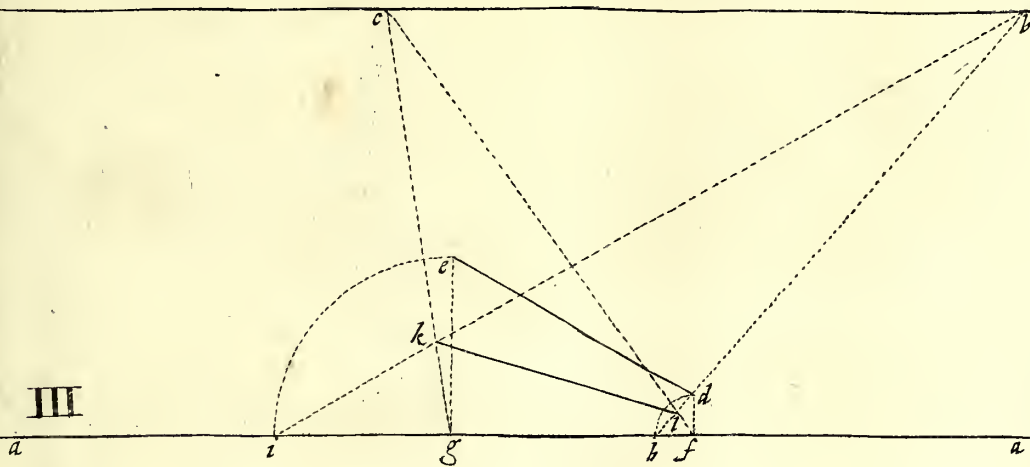
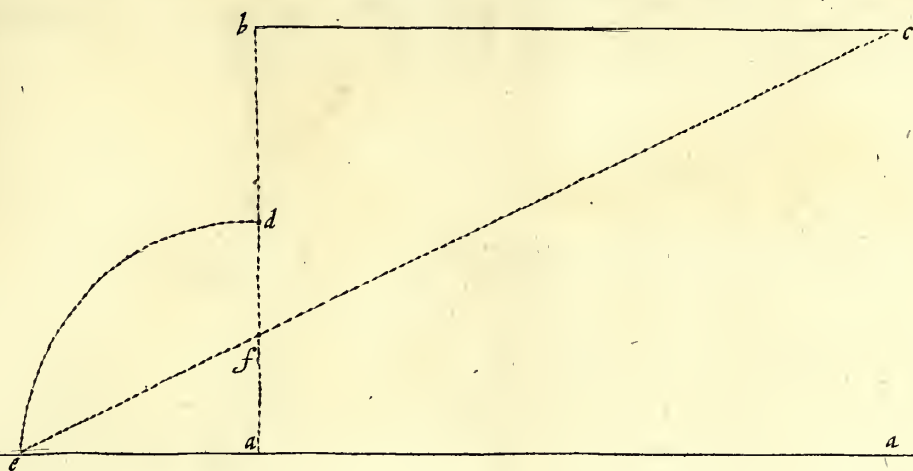
HAVING fixed your Plain fast, and also fixed your Tube fast directly before the Plain, look through the little Hole at the hither end of the Tube, and with a point or black-lead pencil mark where the several Angles of each and every Face of the Chrystal falls upon the Plain; so may you with your black-lead pencil draw a line by the side of a Ruler from point to point of each Face thus found on your Plain. But you must remember to mark each Face on your Plain with numerical figures or some other mark, so as you may know to what Face of your Chrystal each belongs: for you will find them all reverted; that is those seen through the top-faces of your Chrystal will be in the bottom of your Plain: and those seen through the right hand Faces of your Chrystal will be on the left hand on your Plain.

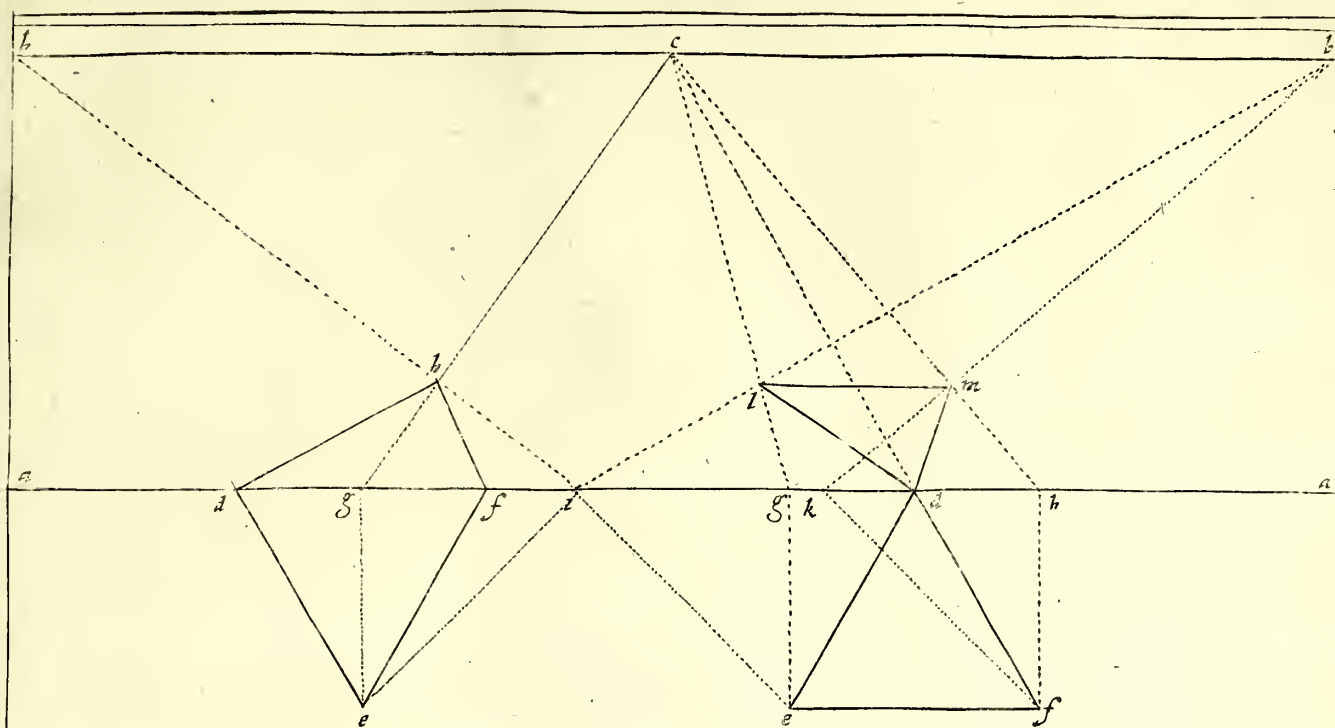
Having thus prepared your Plain, you must draw the figure of your Chrystal (on a plain paper) exactly of the size of your Chrystal, and divide it into so many parts your Chrystal is divided and cut into Faces; and mark each division thereon in a reverted order from that on your Plain: As if the bottom Face on your Plain be marked 1, then mark the top-Face in your paper 1; And if 2, 3, 4, &c. be marked towards the right hand on your Plain mark them towards your left hand on your paper; as you see in the Figure. On this paper therefore you must draw the Picture you intend shall be seen on the Plain: Suppose the Picture of King *Charles* the first: and having drawn it; transfer all the lineaments and strokes you find in each respective Face on the paper to the responding Face on the Plain. As for example: What lineaments you find in the Face marked 1 on the paper, transfer to the Face marked 1 on the Plain: what lineaments you find in the Face marked 2 on the paper, transfer to the Face marked 2 on the Plain. And so for all the rest.

Then looking again through your Tube, you will see all the severed Faces on the Plain unite, each Face contributing the lineaments drawn in it to form your intended Picture of.

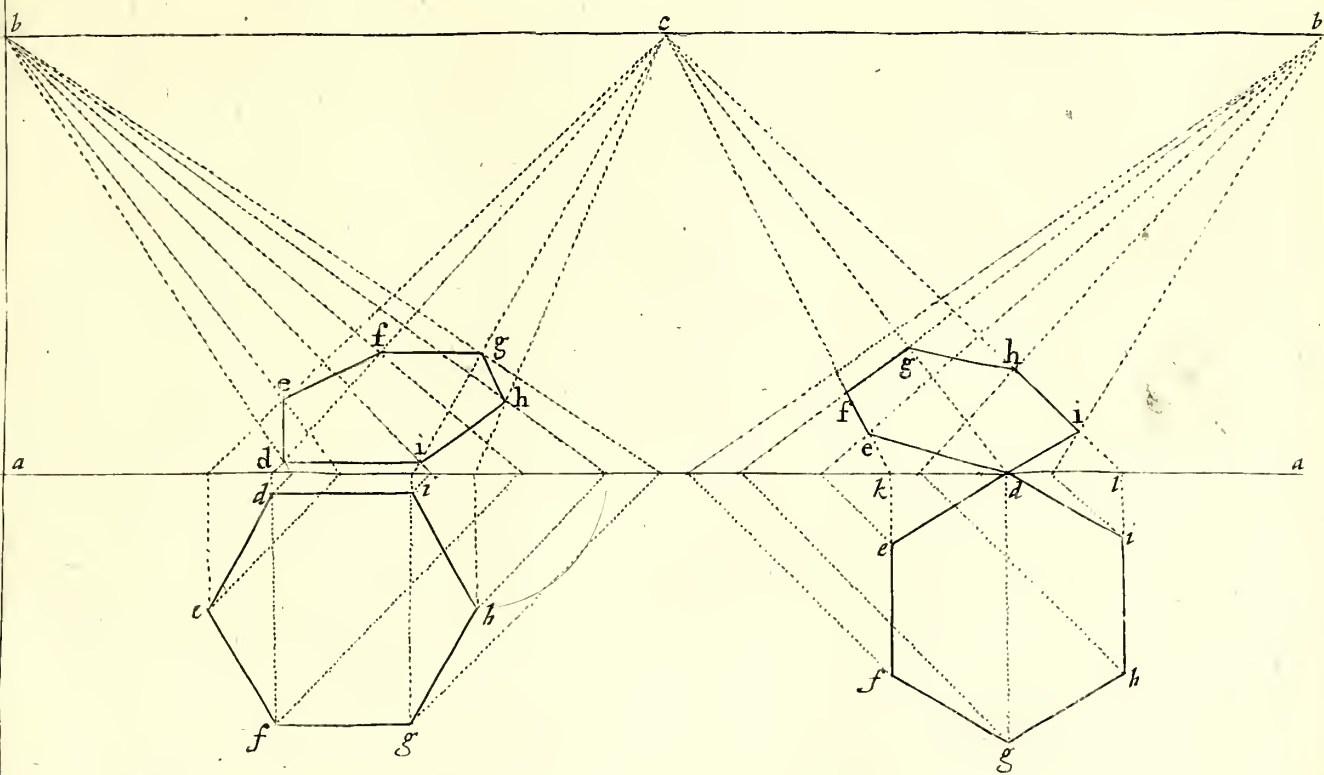
If you have a mind further to amuse Spectators, you may to every one of the Faces on the Plain draw another Picture: as in the Face marked 10 on the Plain you find an Ey, to this Ey make up an whole Figure; To the Face marked 12 you find the Mouth, to this make up another whole Figure &c. But you may alter the likeness as much as you list, both in countenance and dress: So will the conceit appear yet so much the stranger. I have inserted one Example, where about the Face 1 on the Plain, I have set the Picture of Woman.



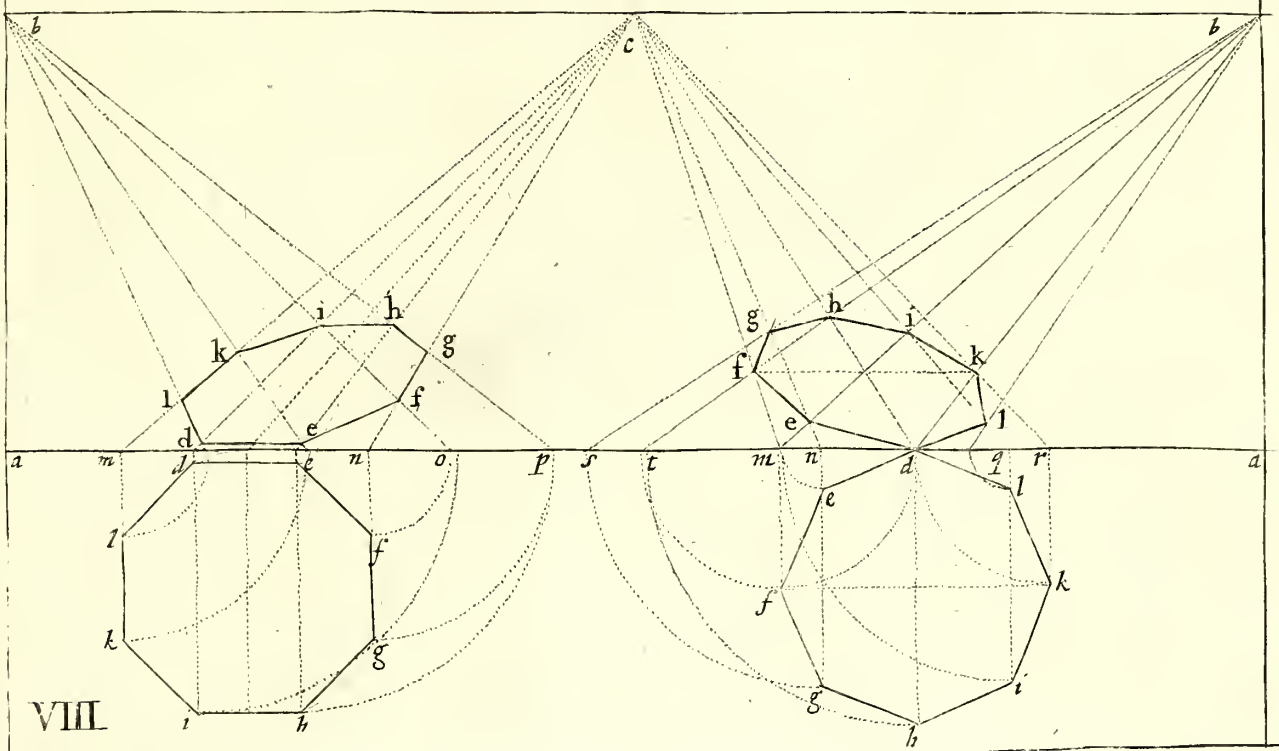
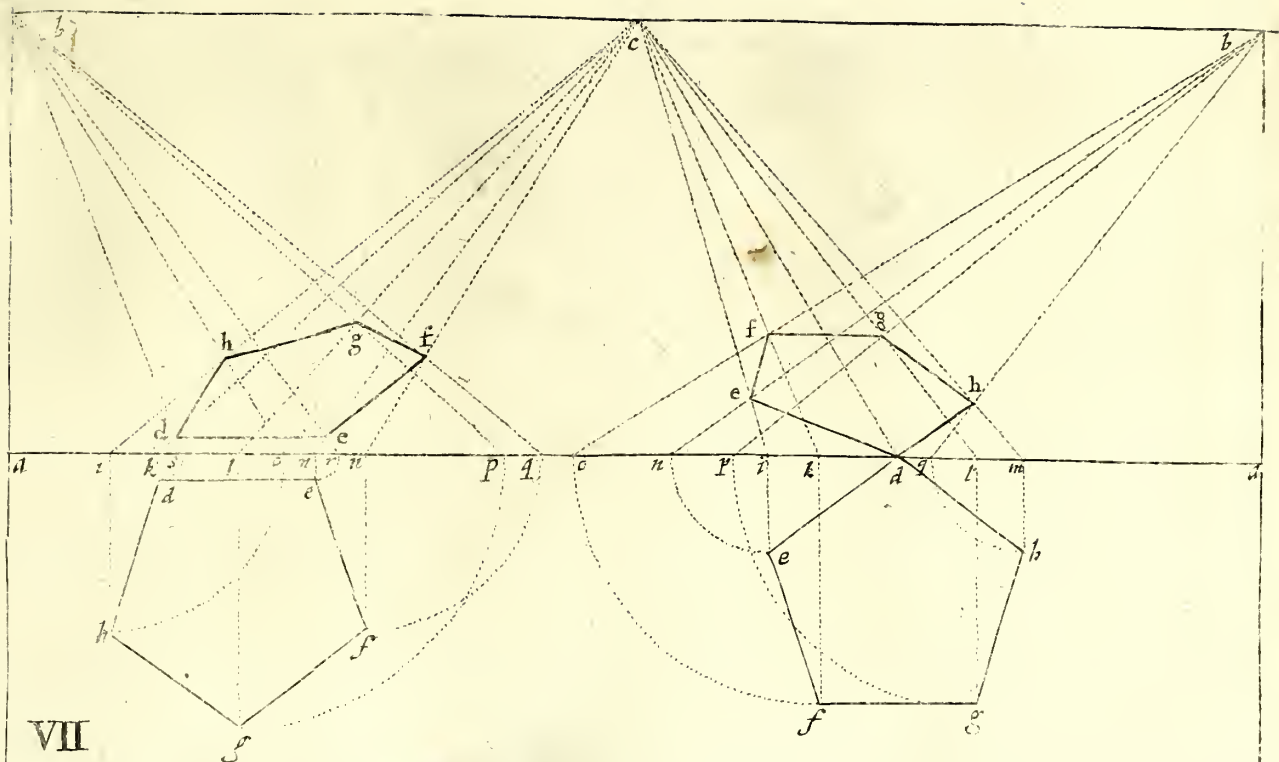


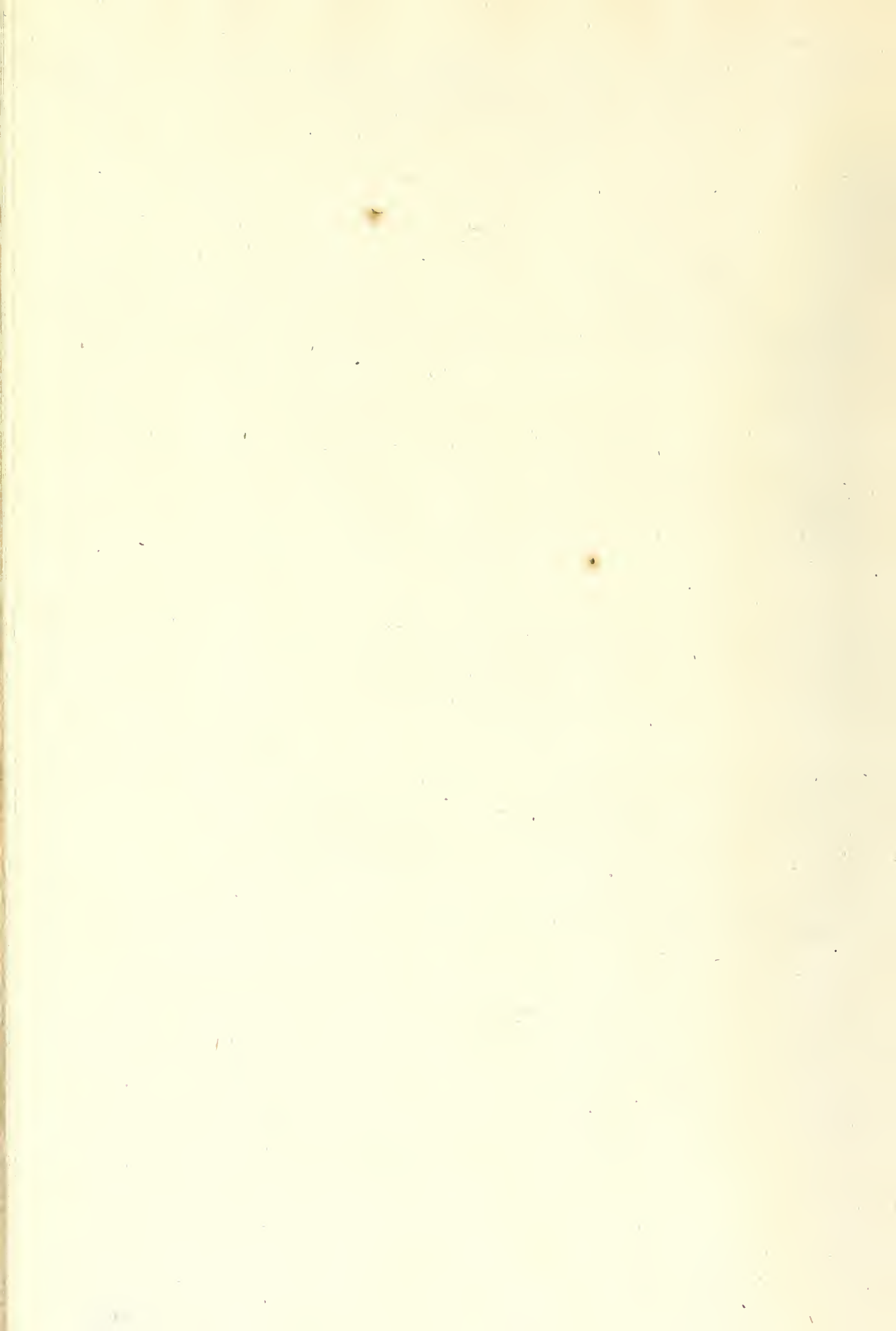


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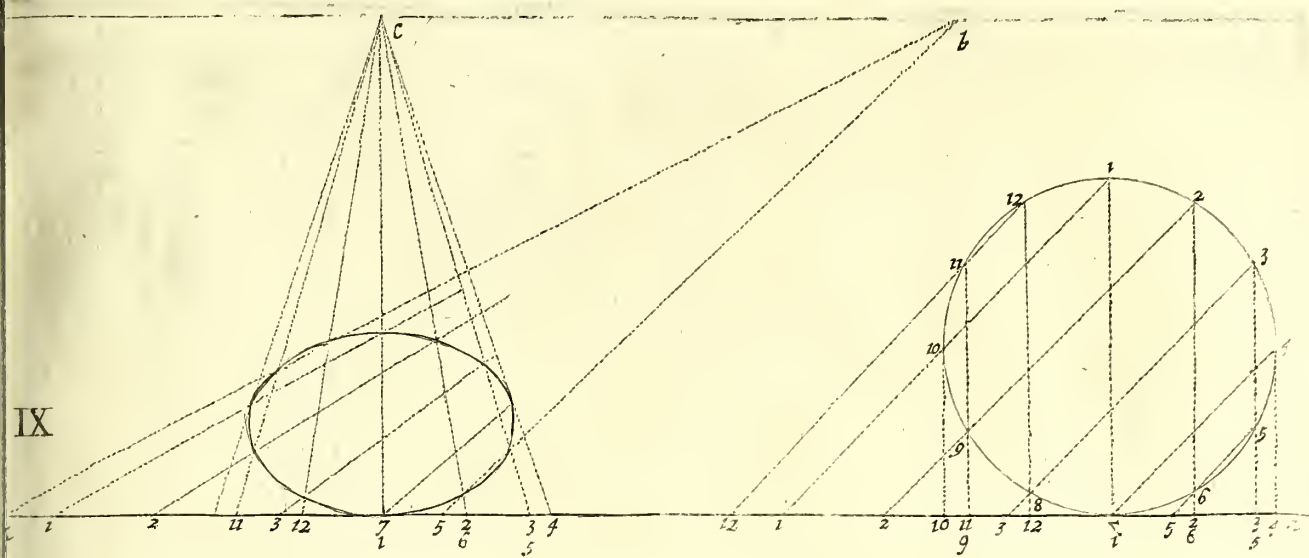


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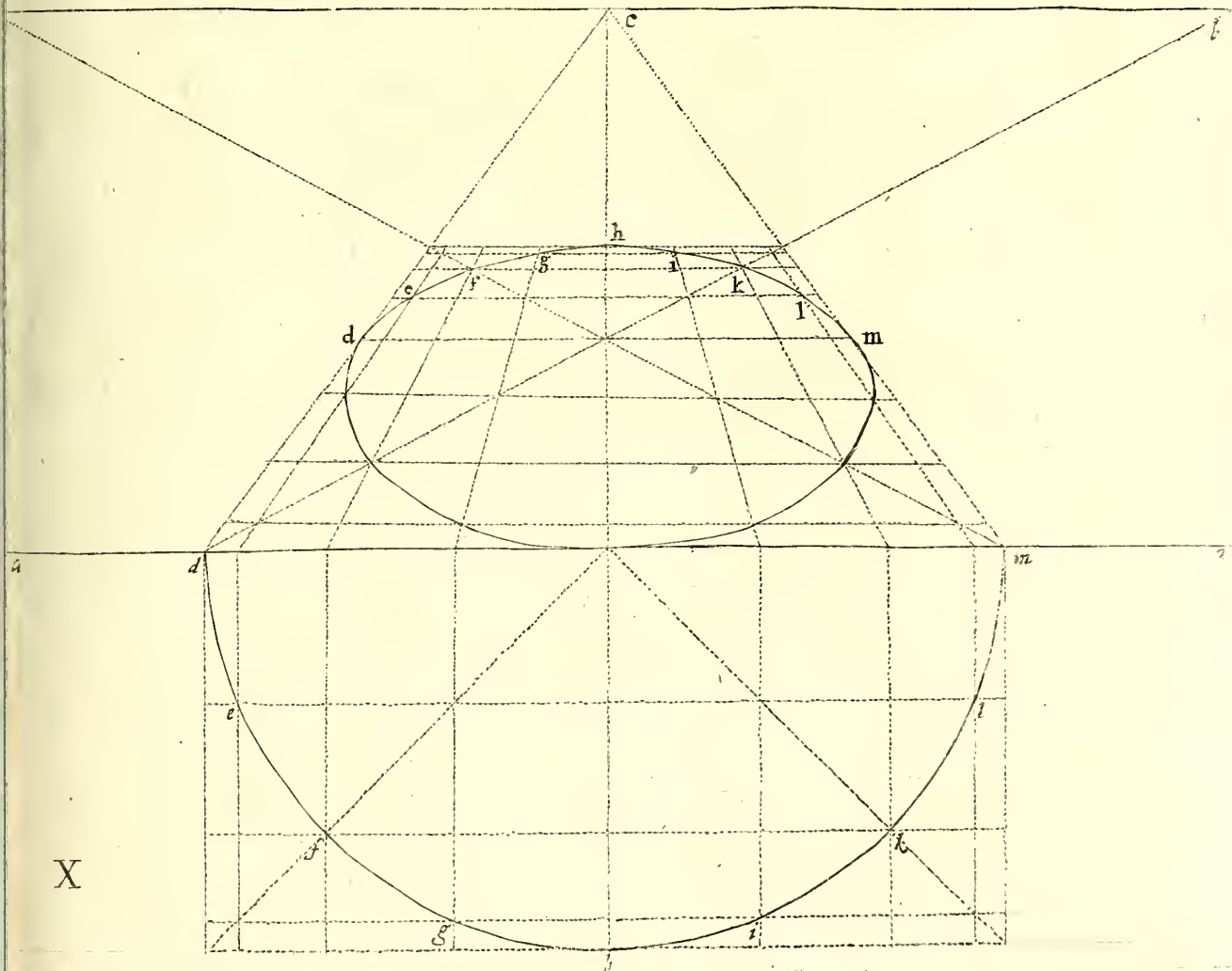


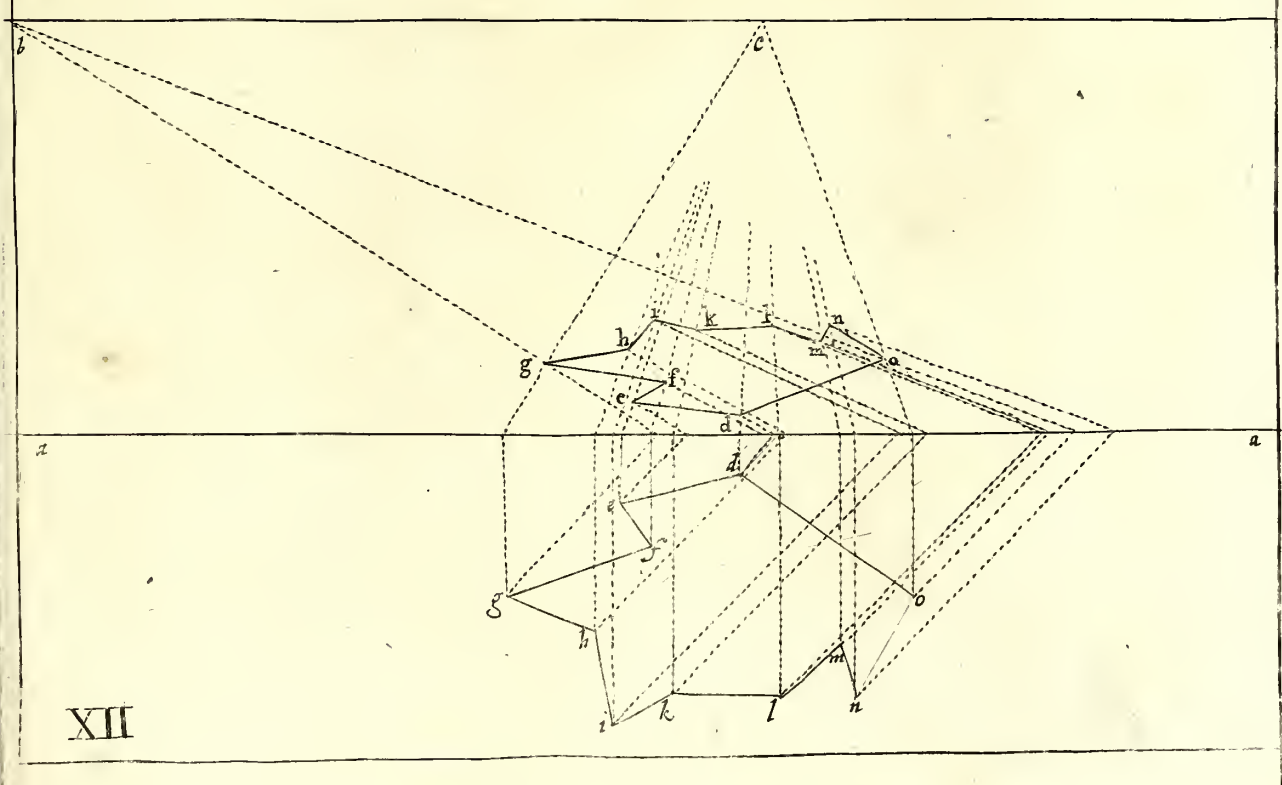
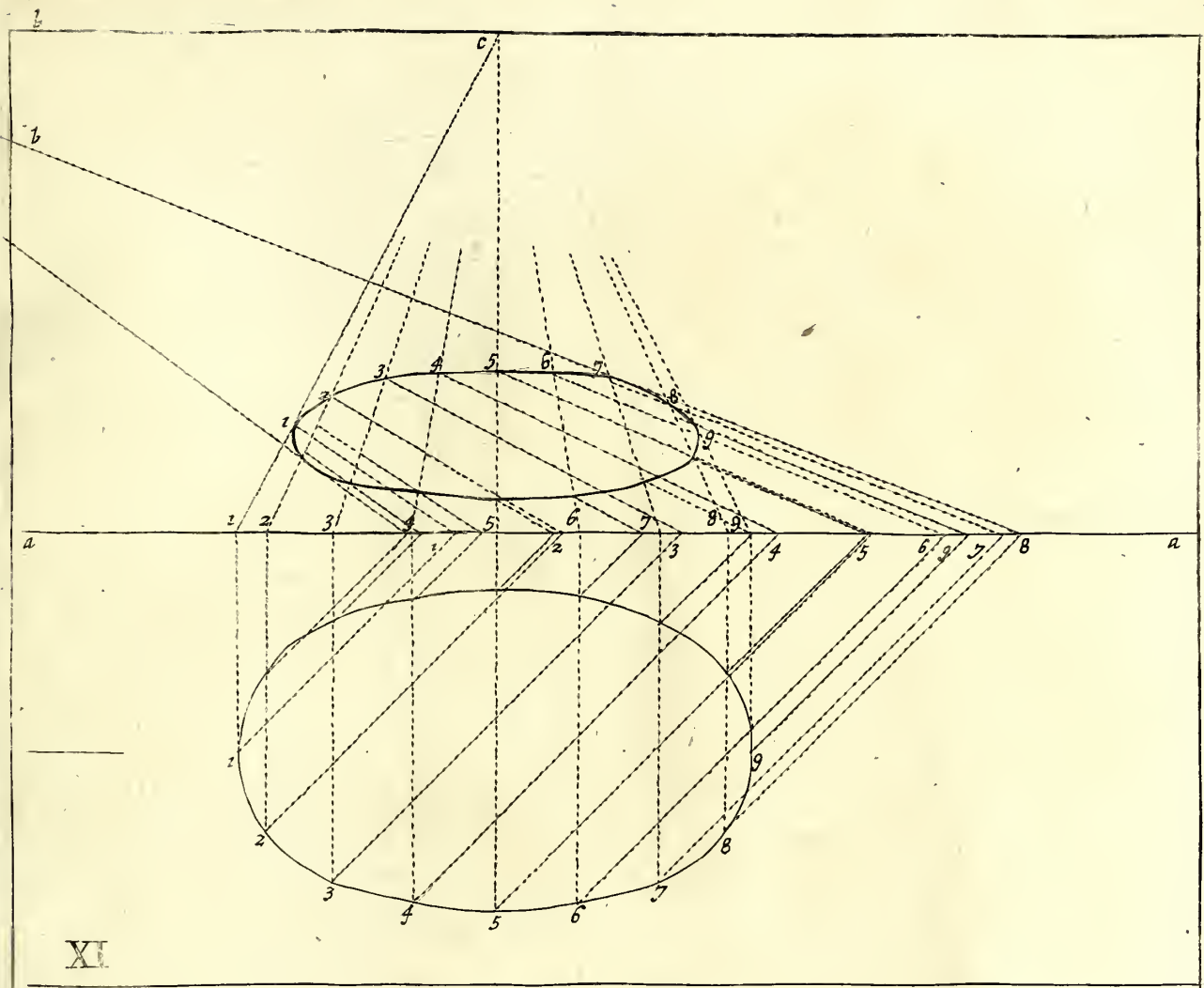


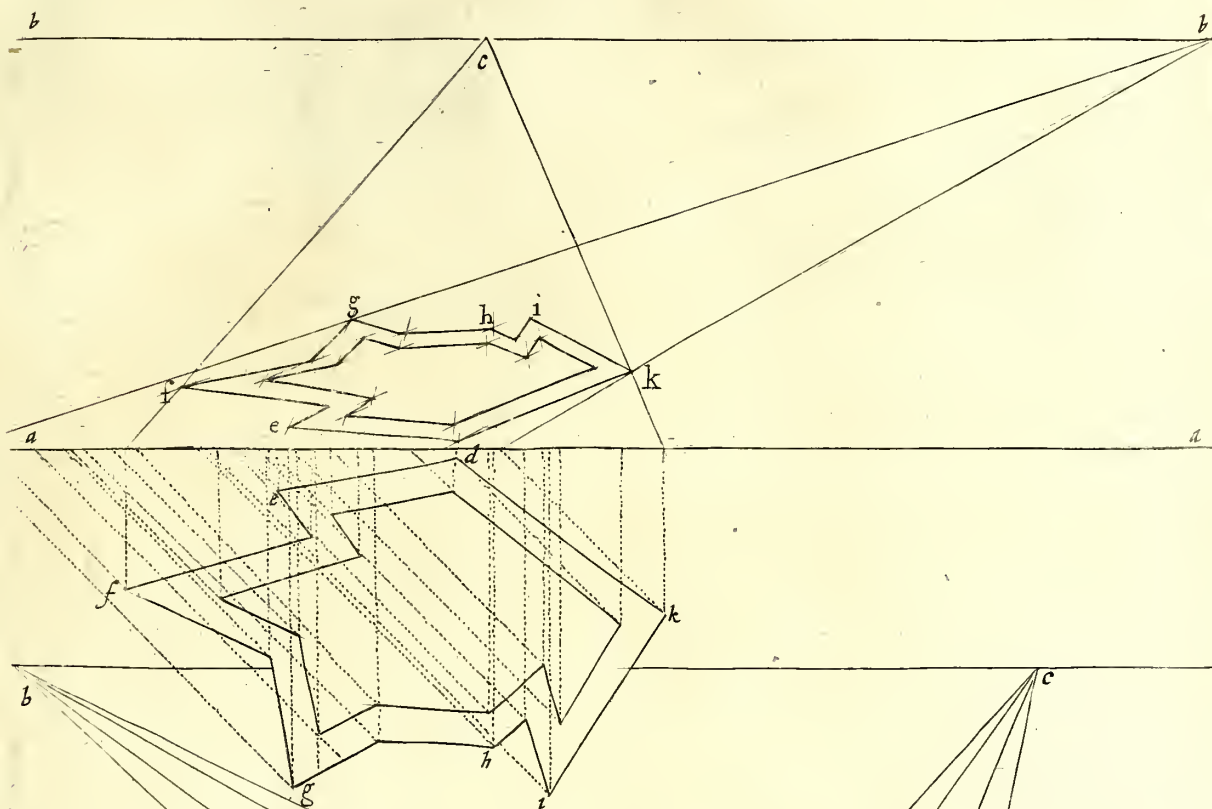
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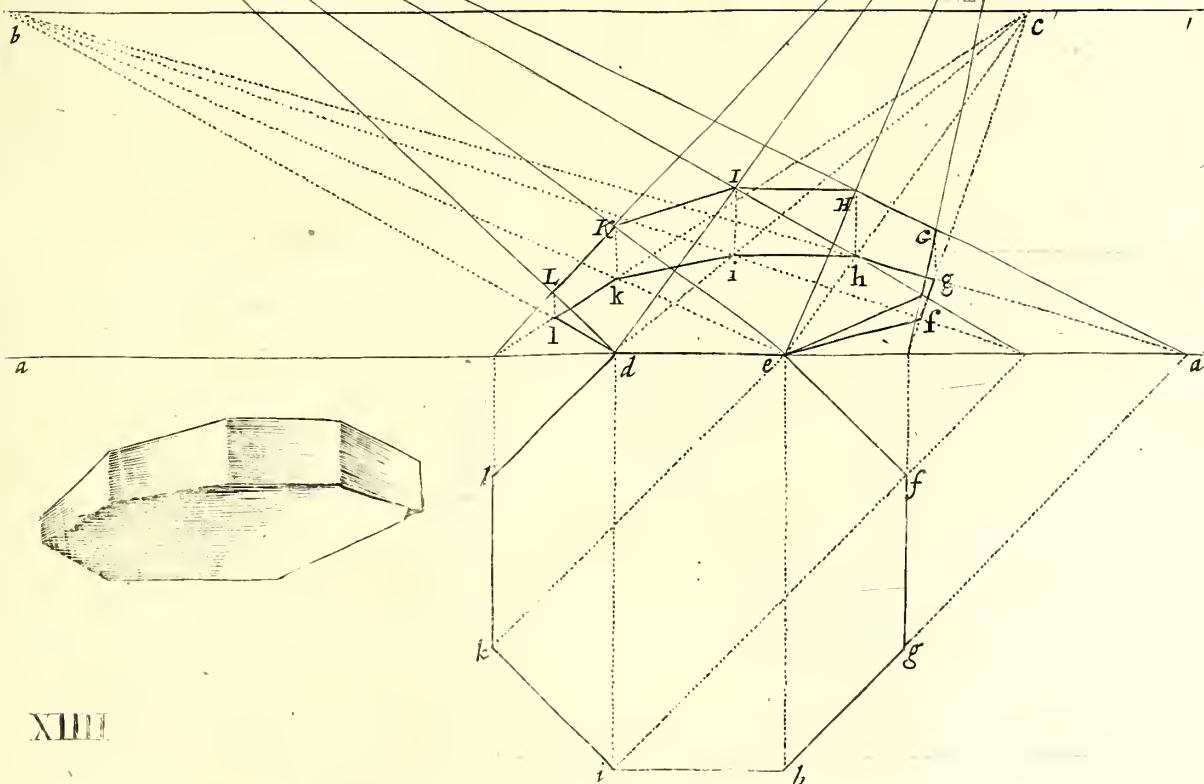
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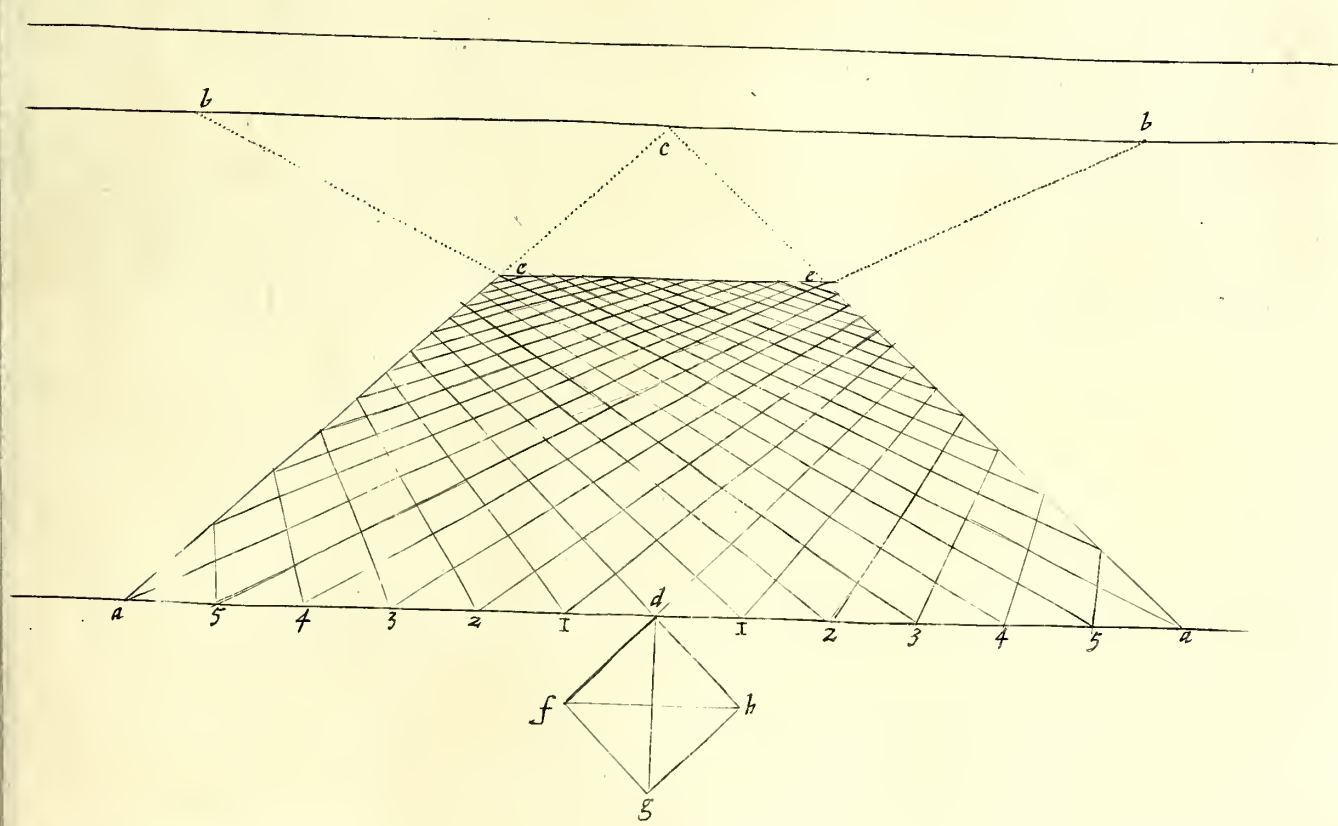
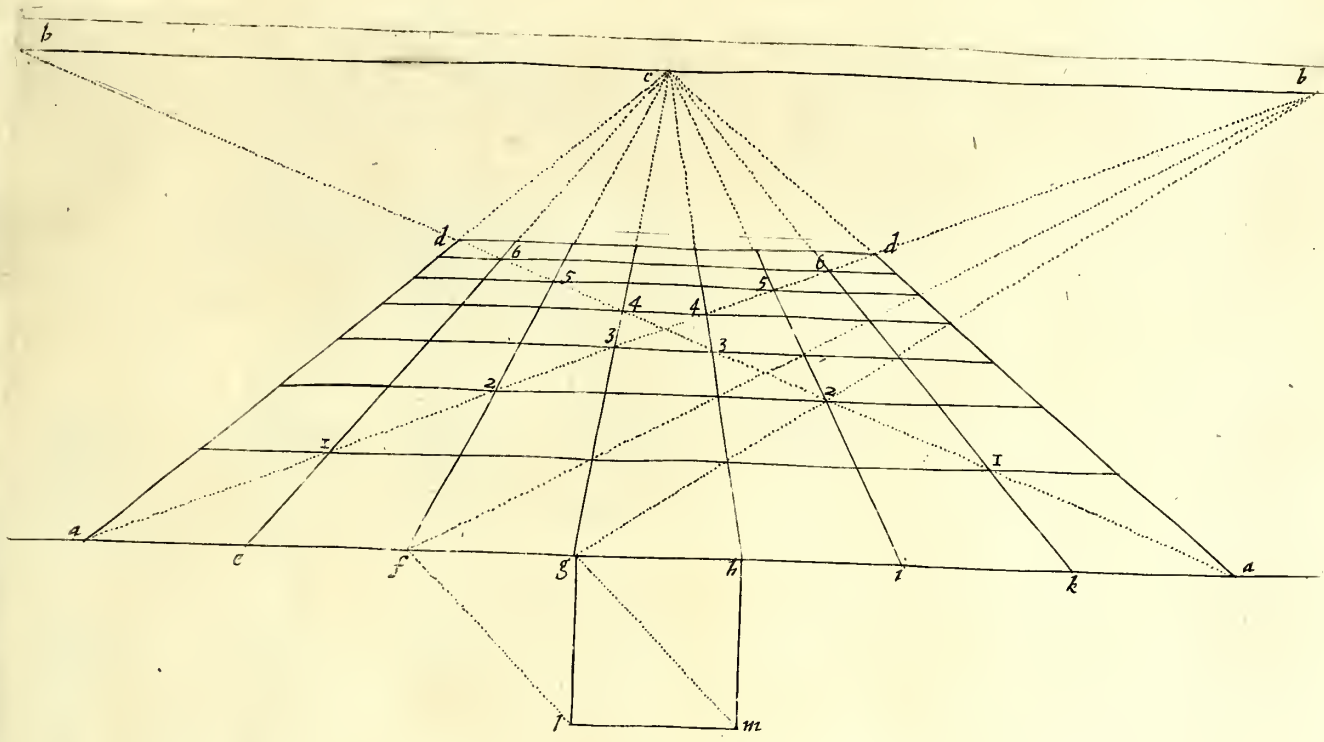




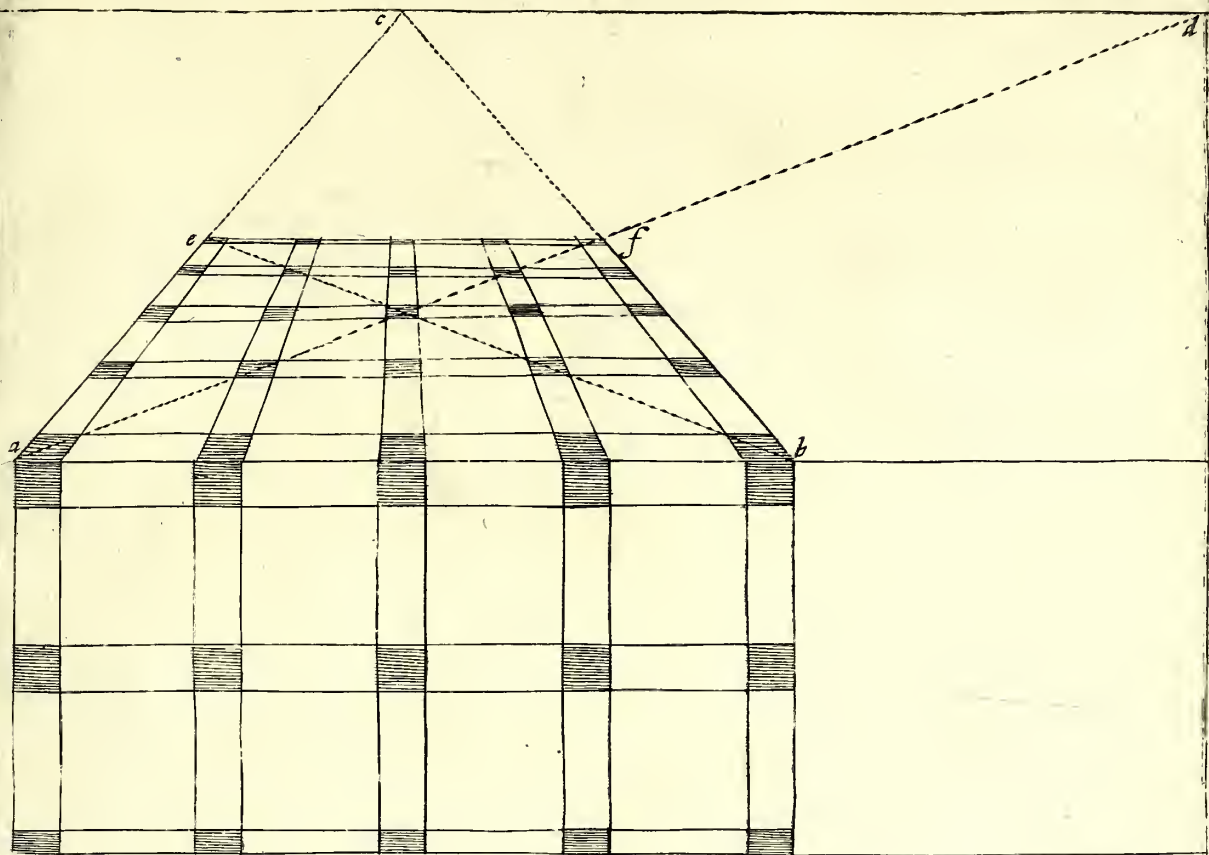
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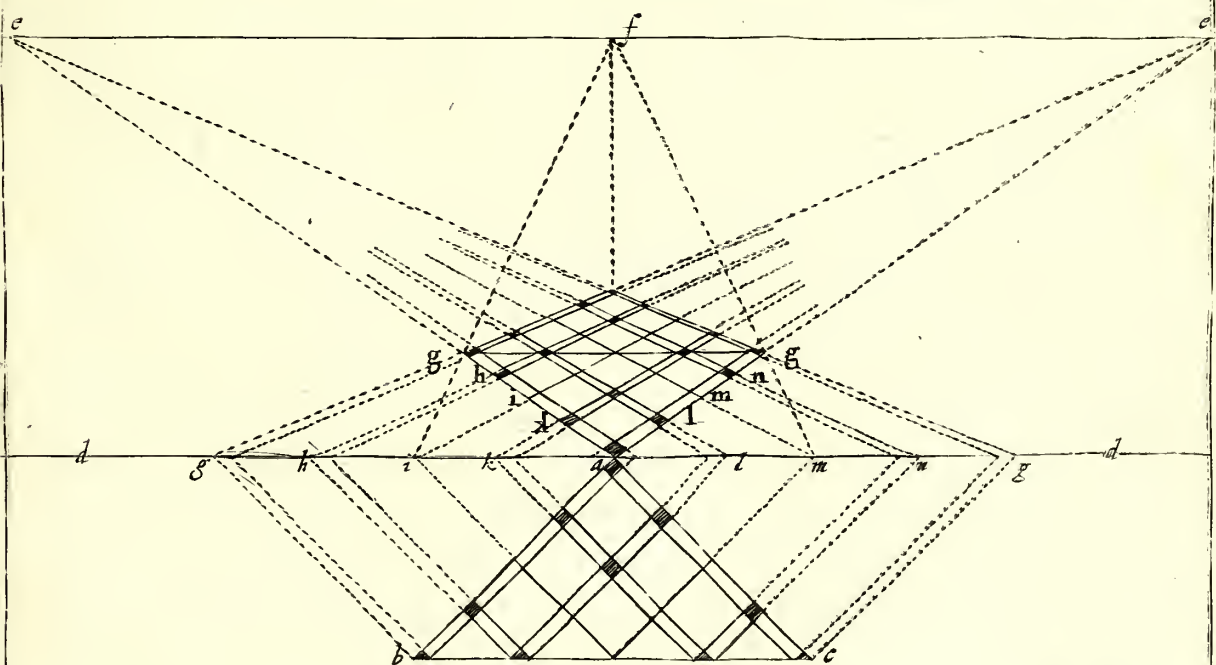
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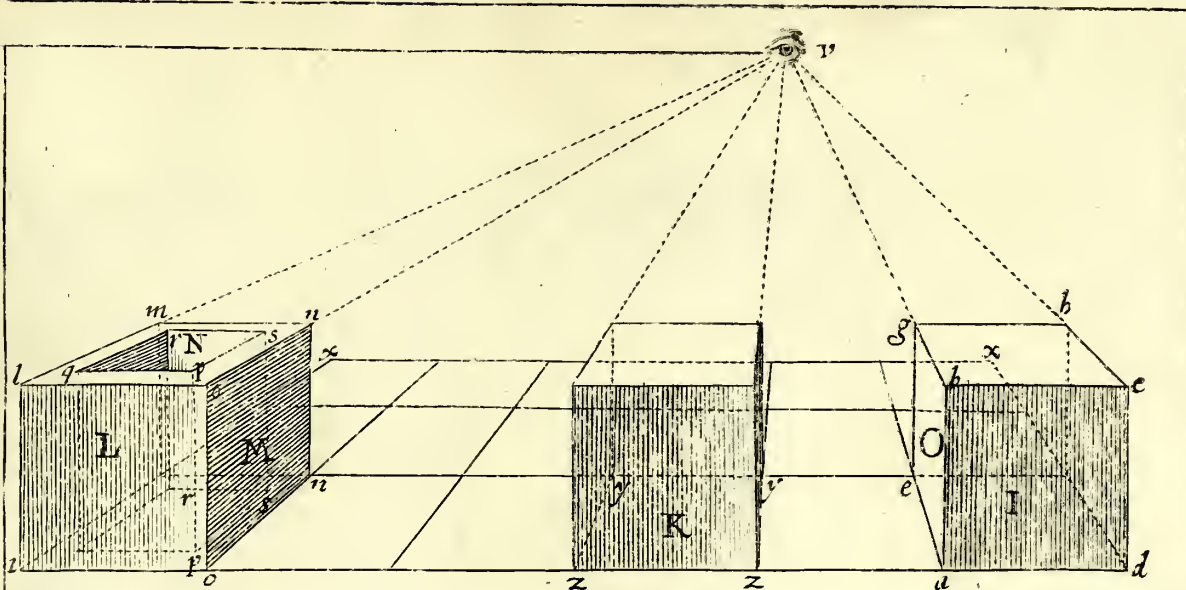




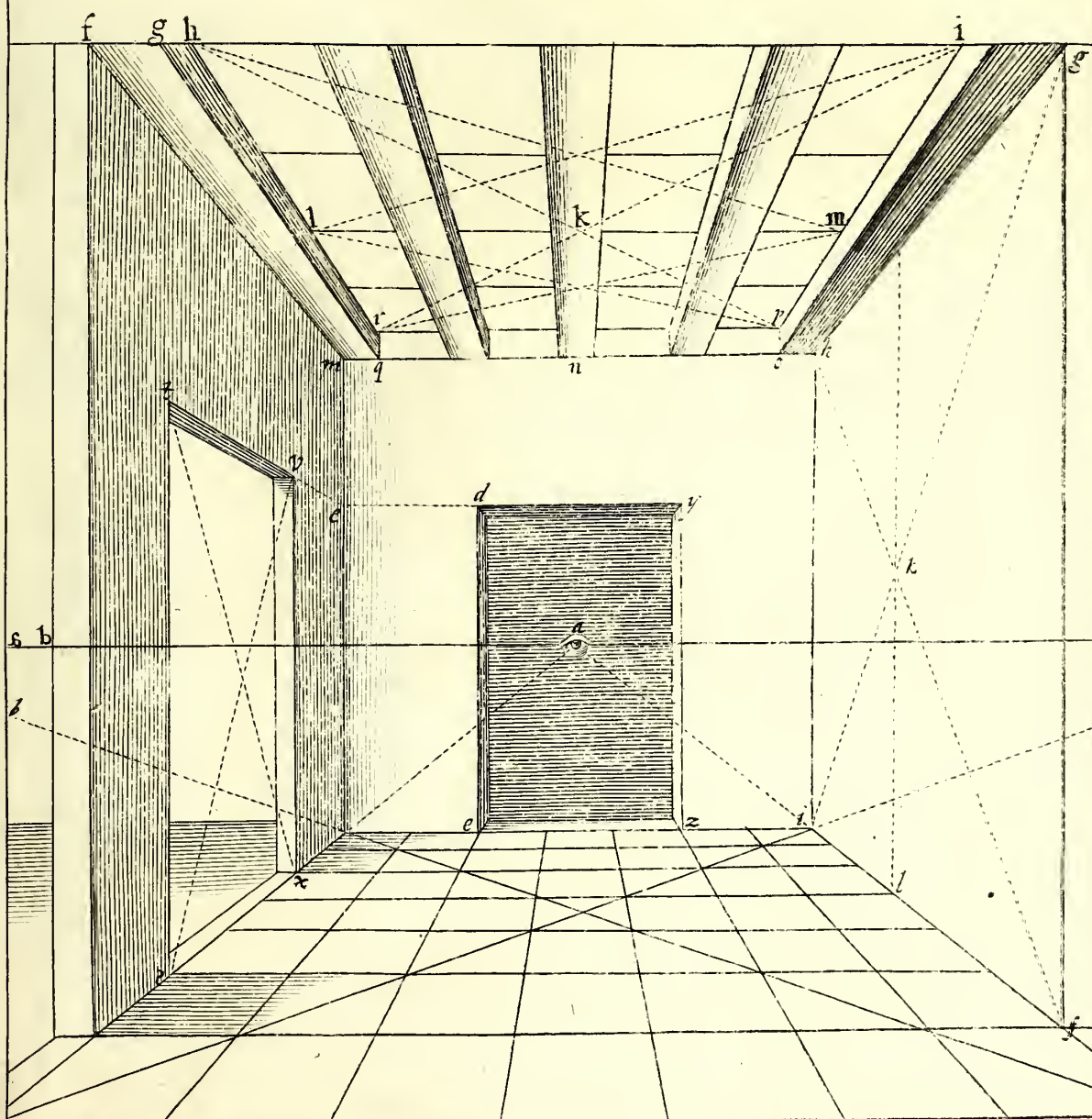
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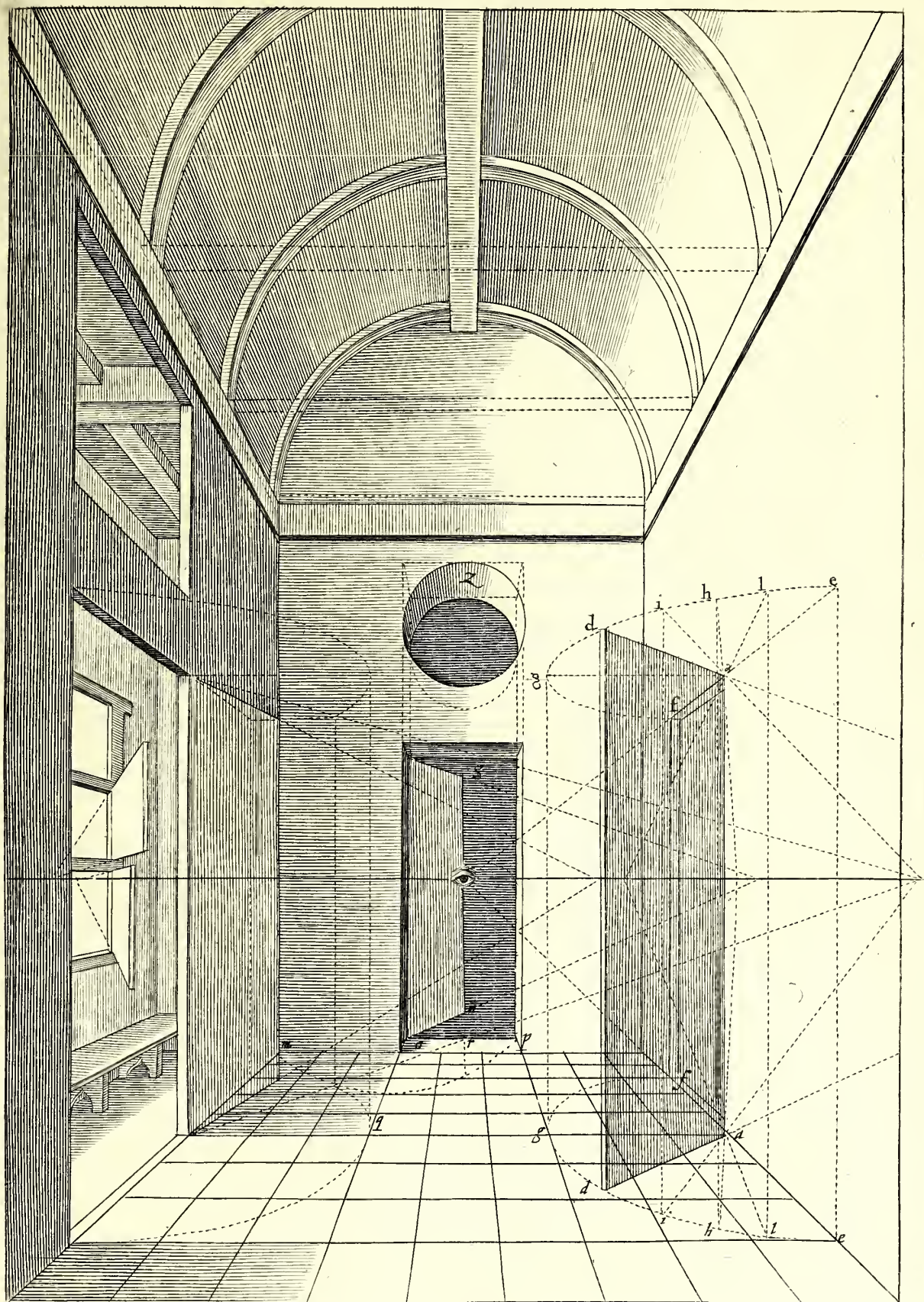
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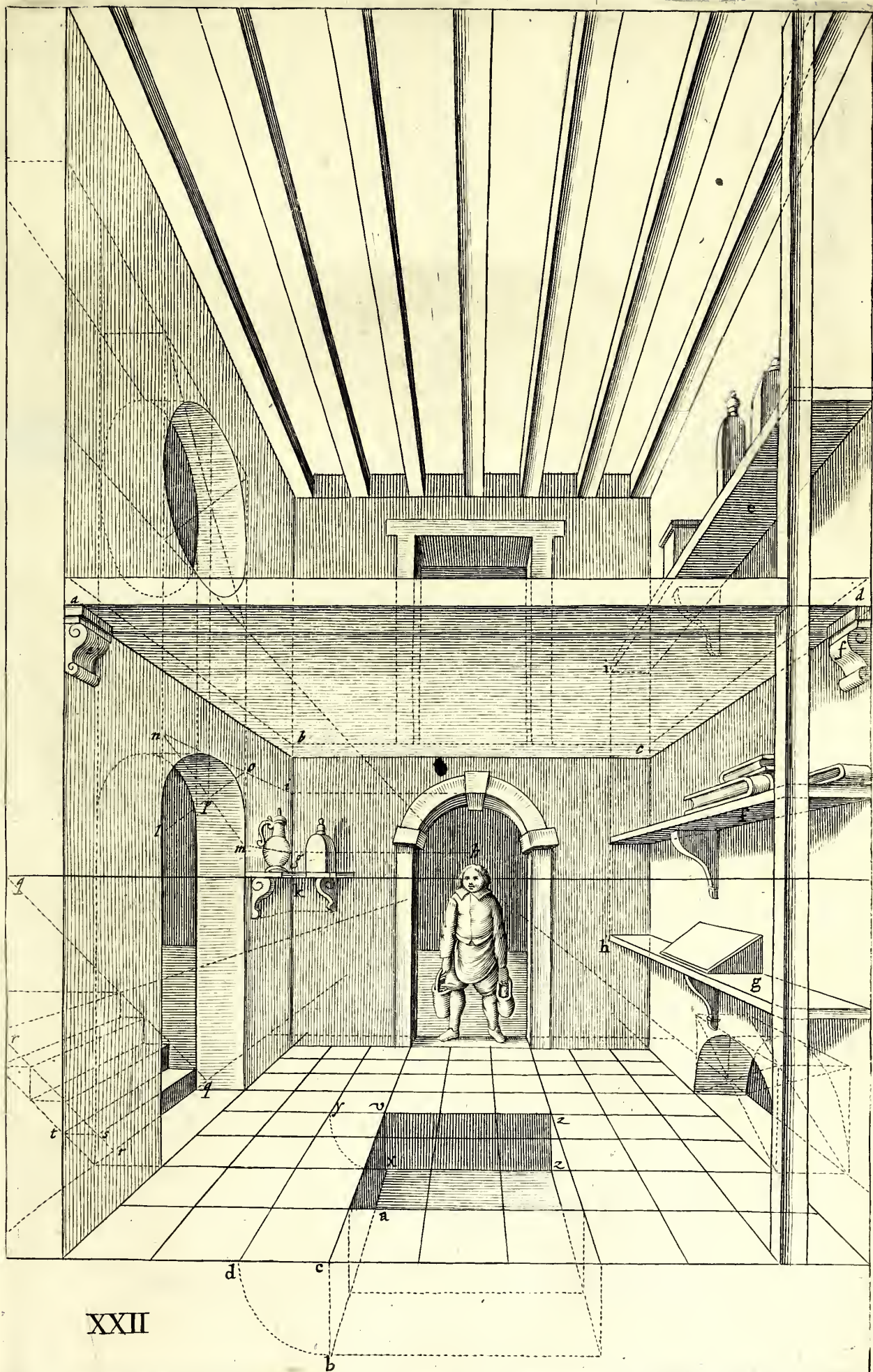
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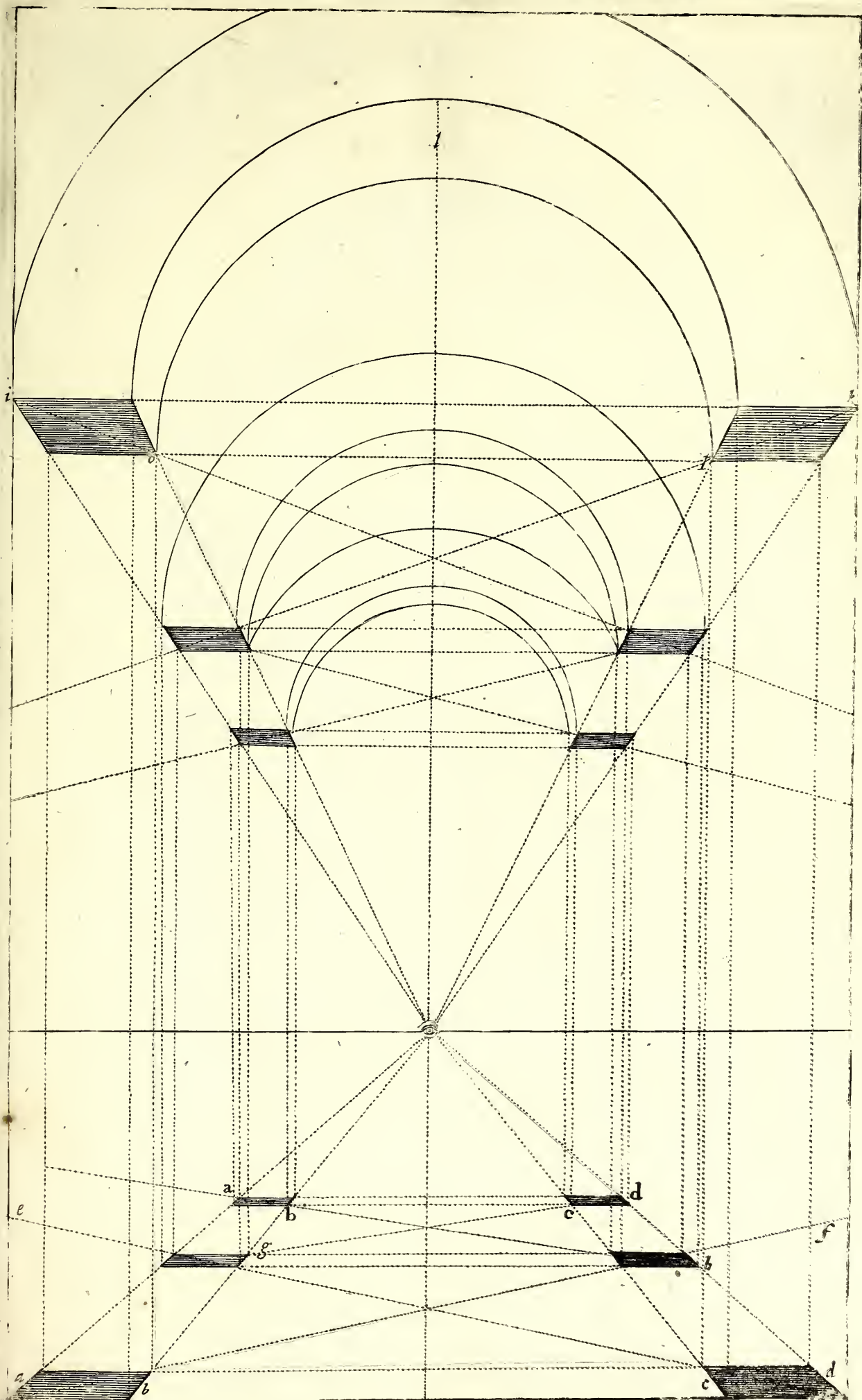


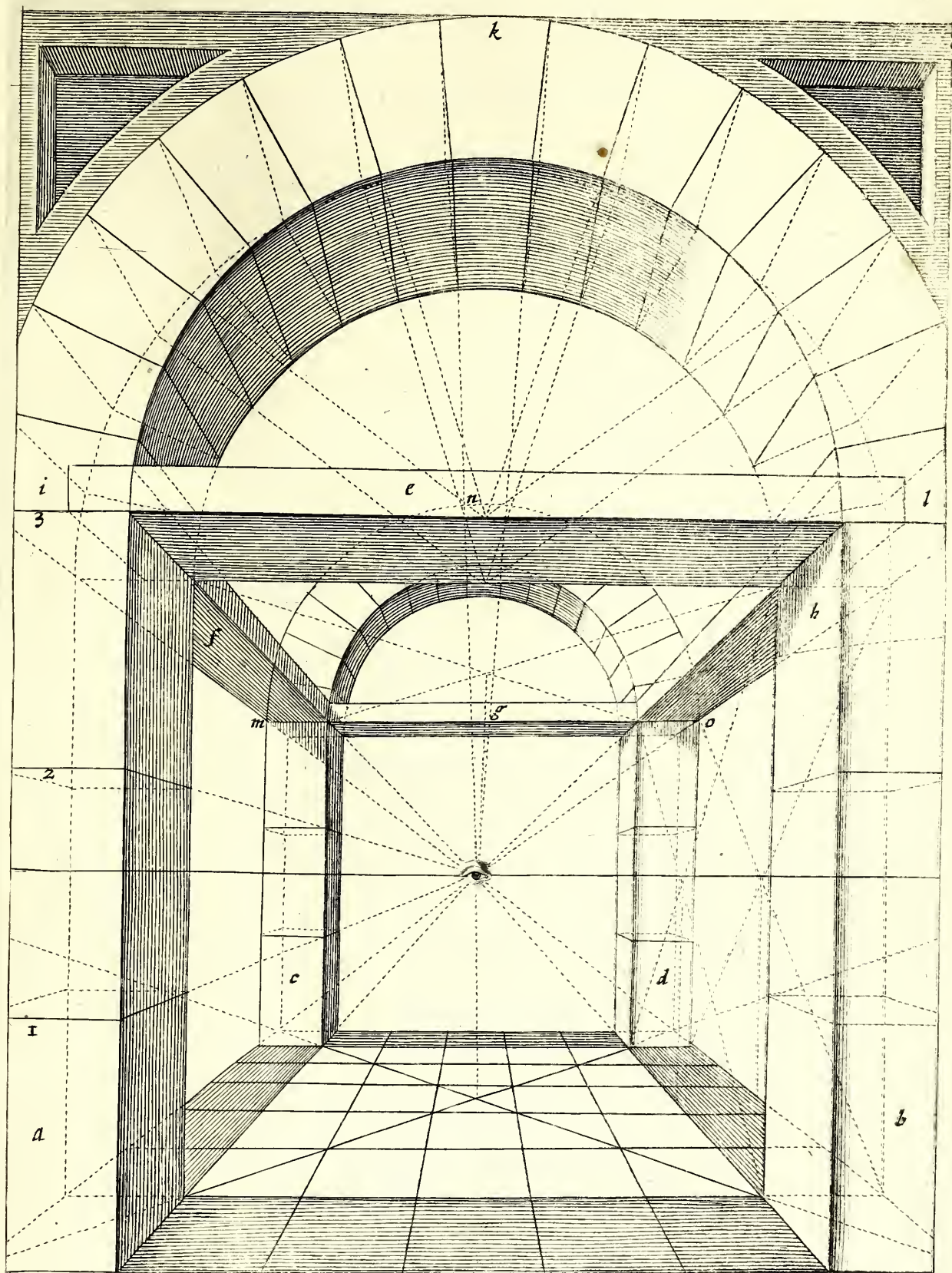
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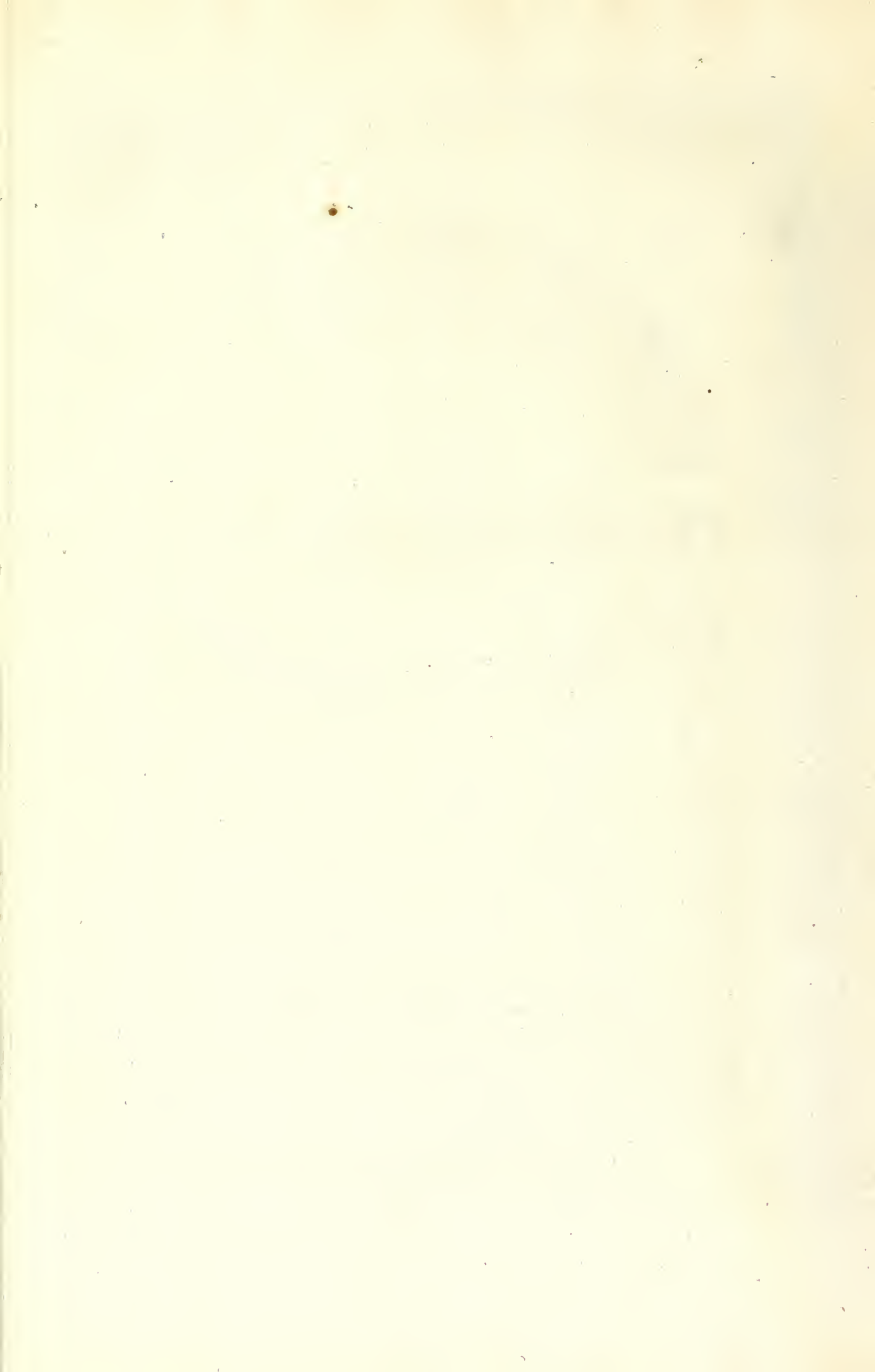


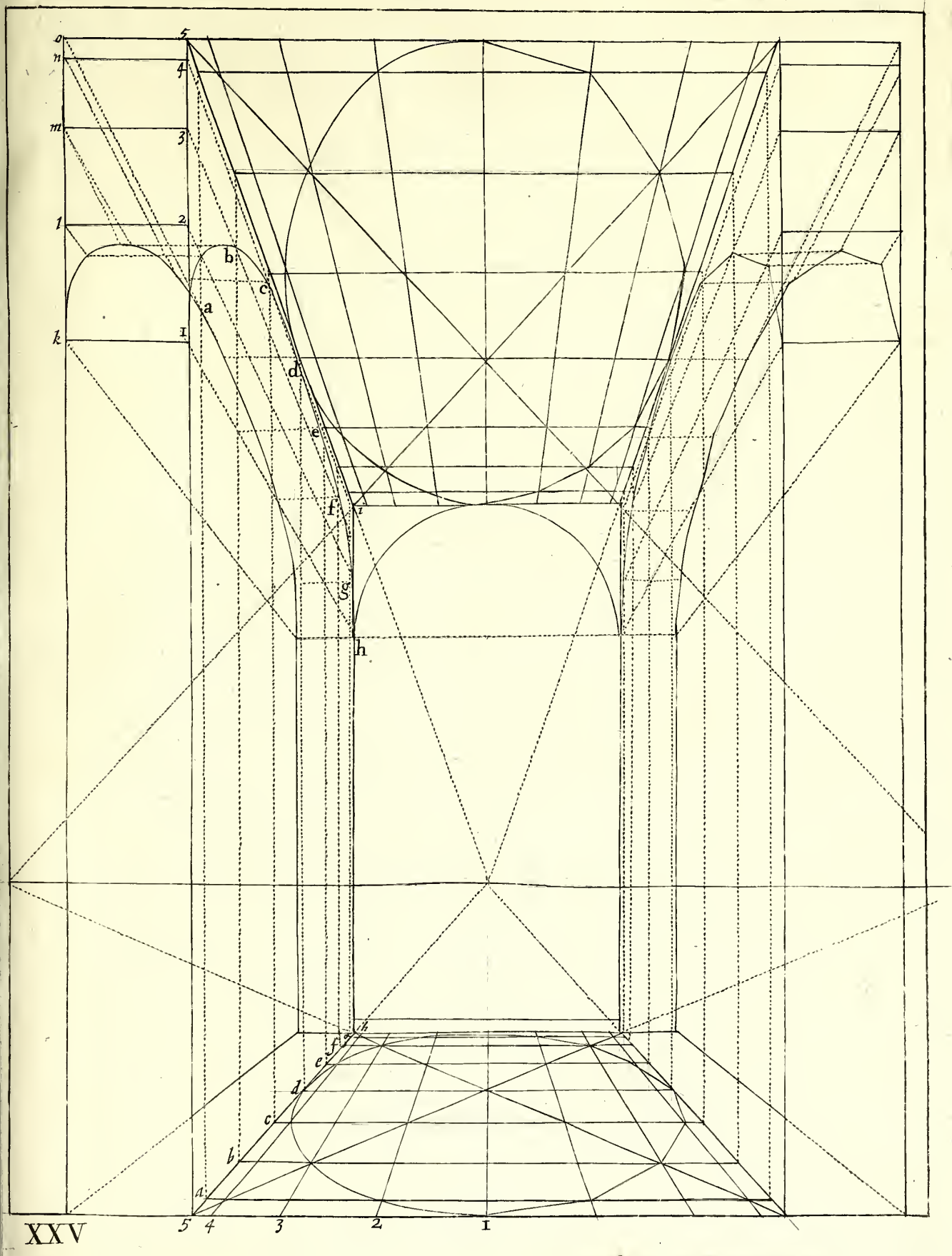


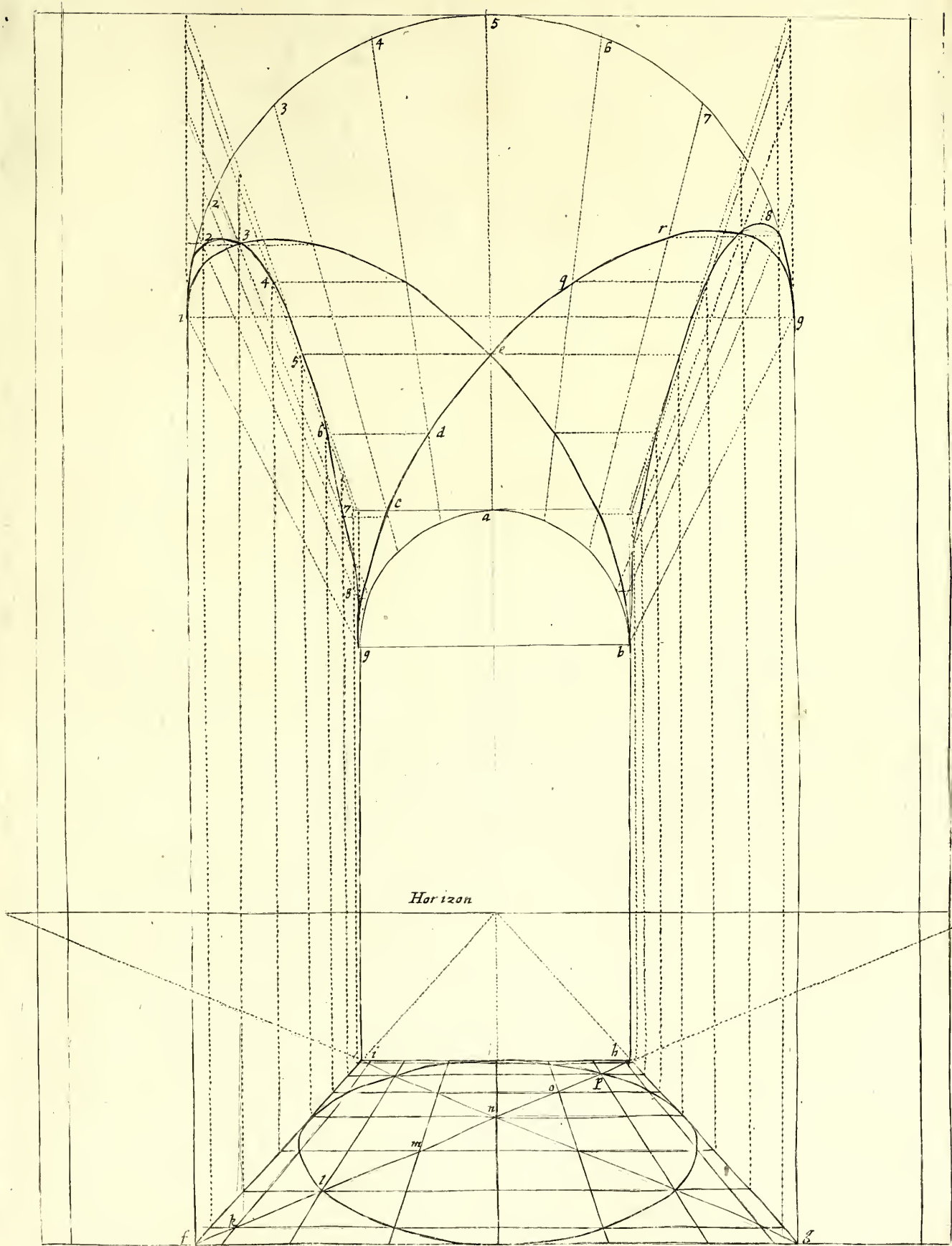


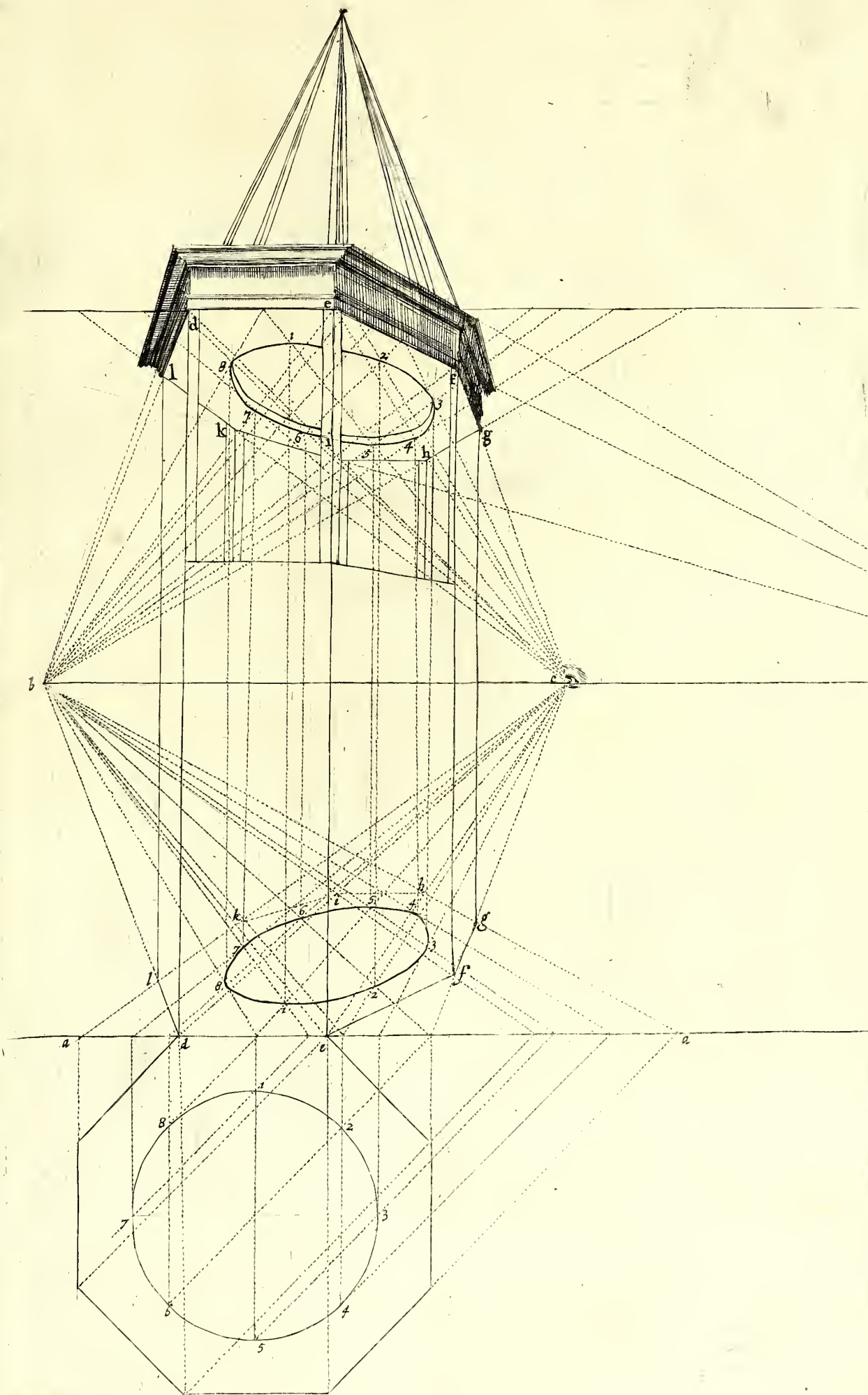


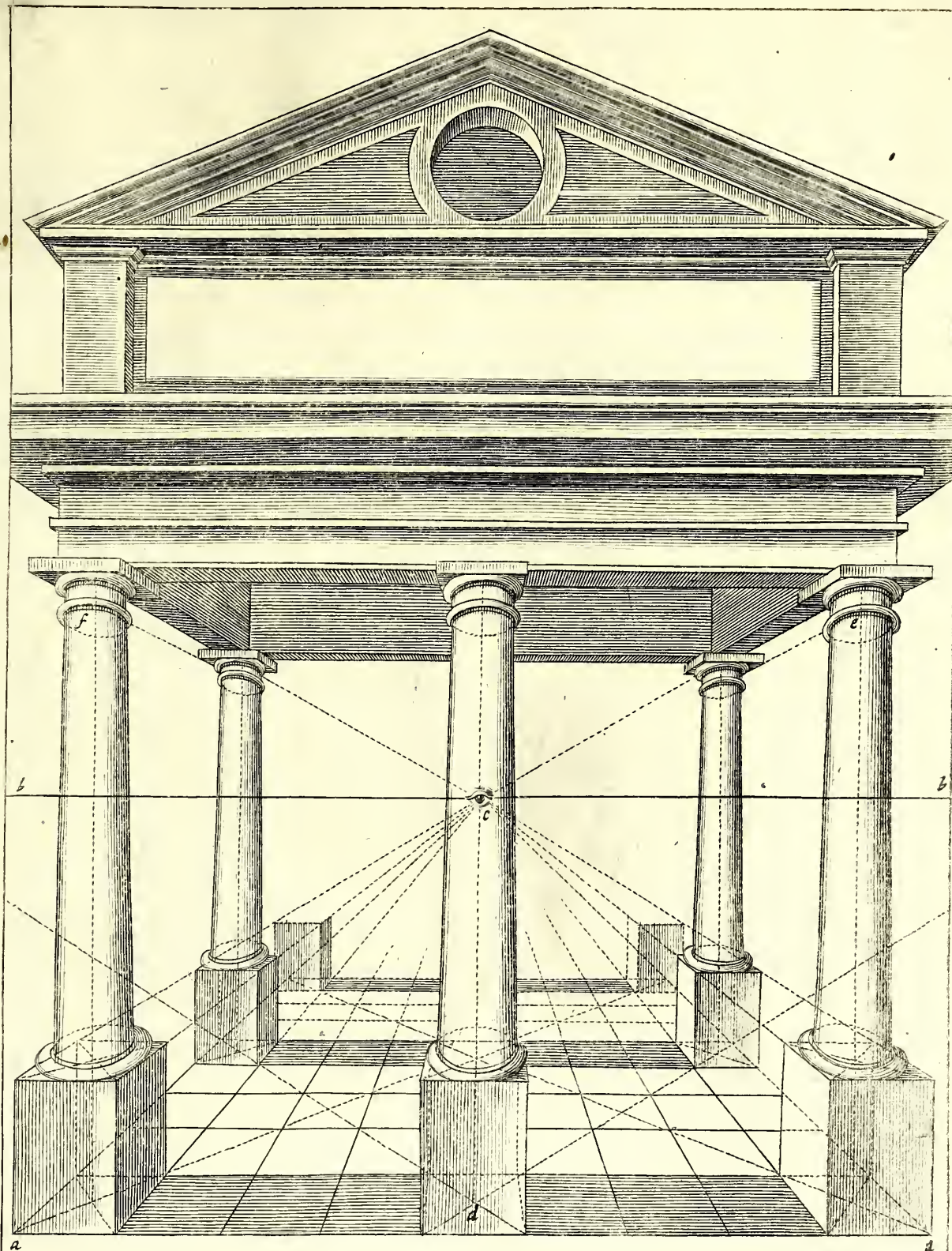


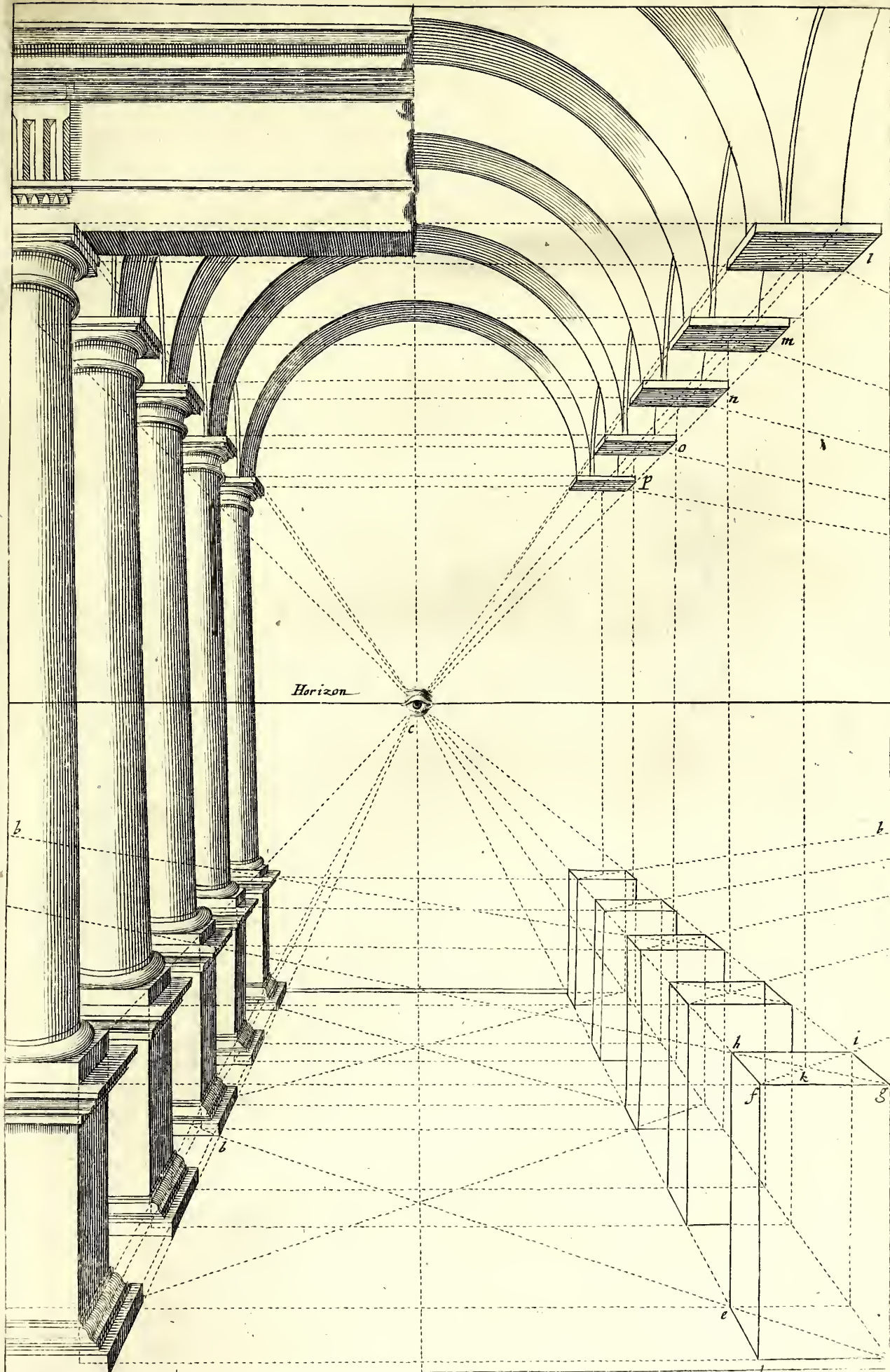




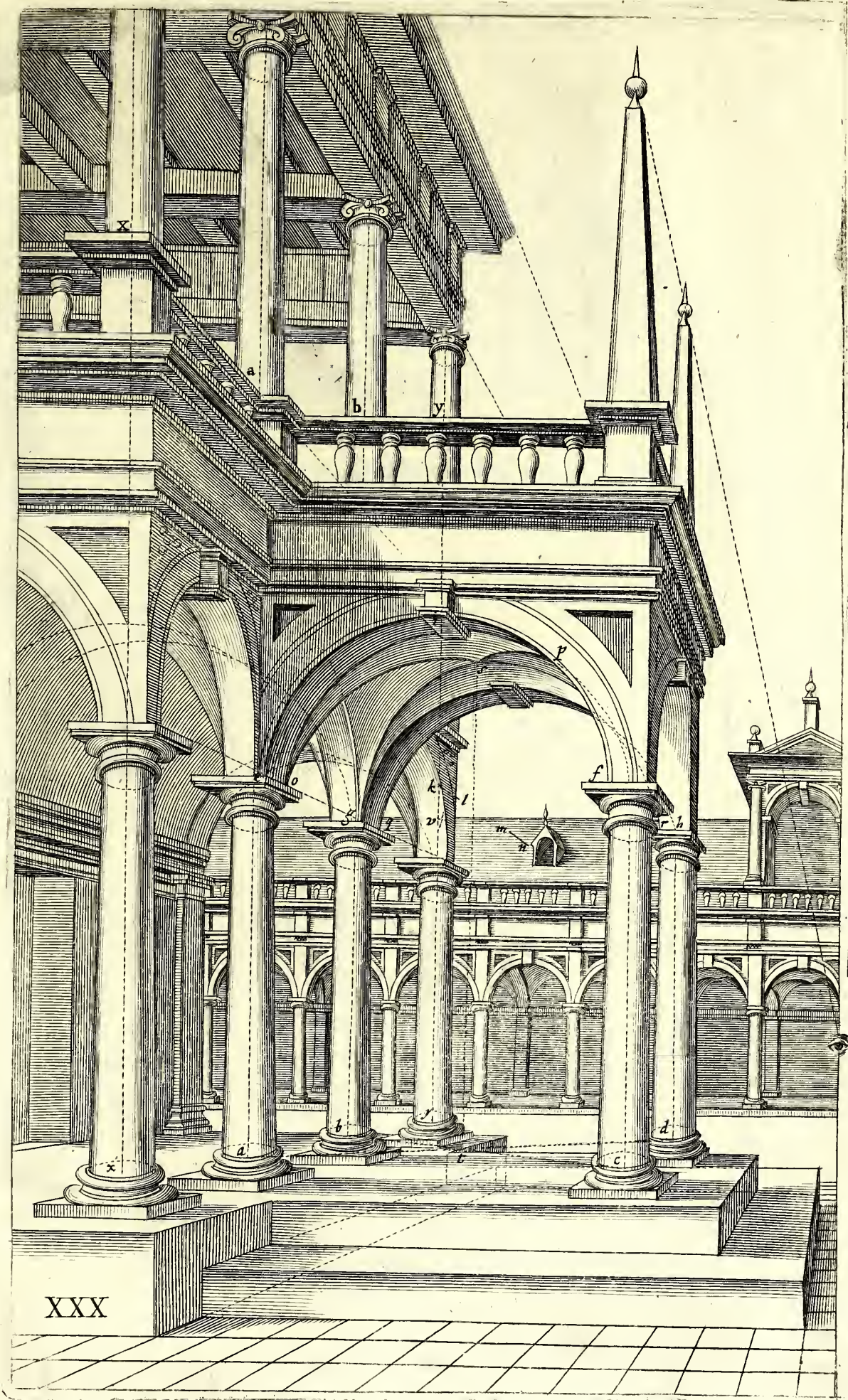


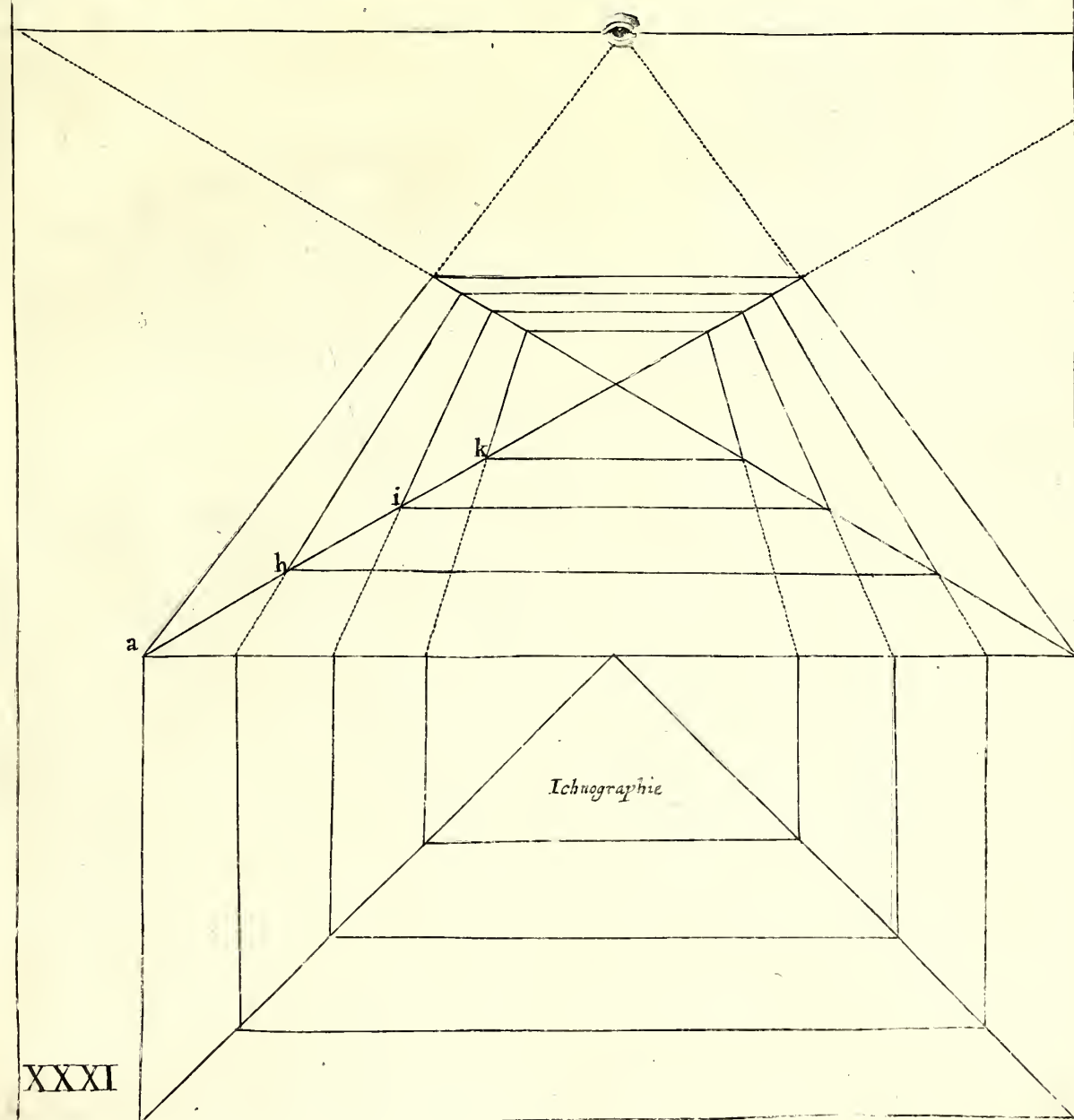
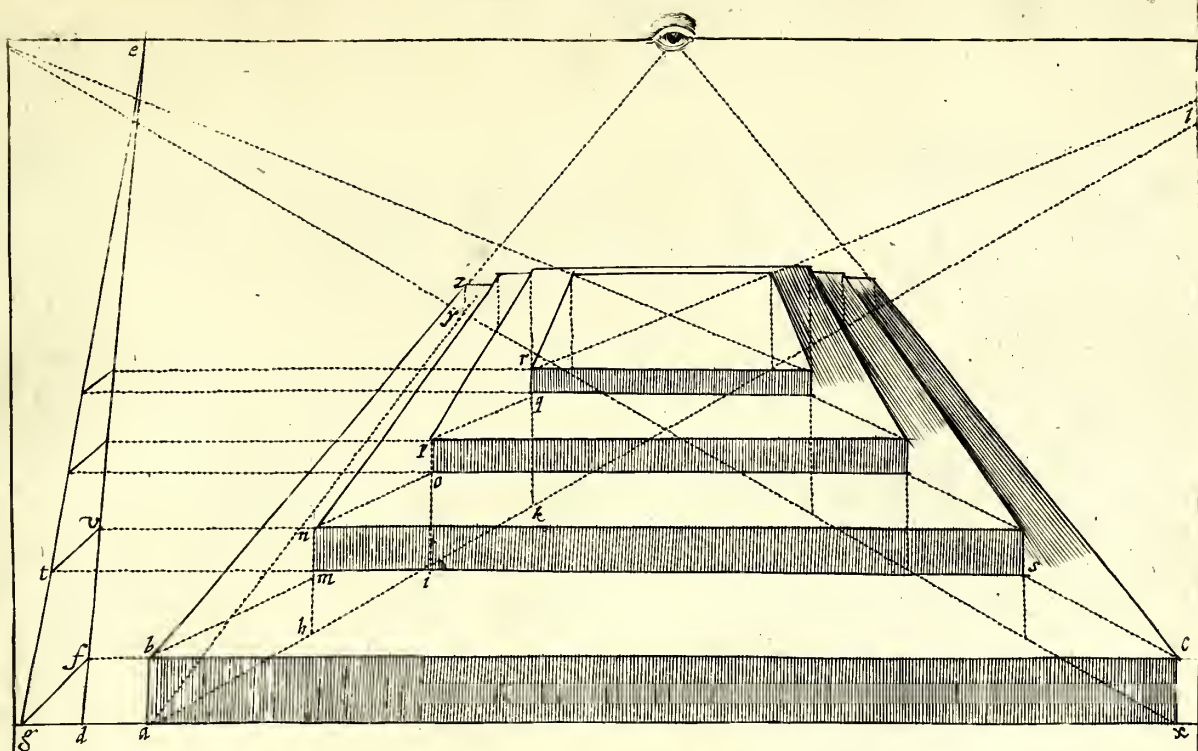






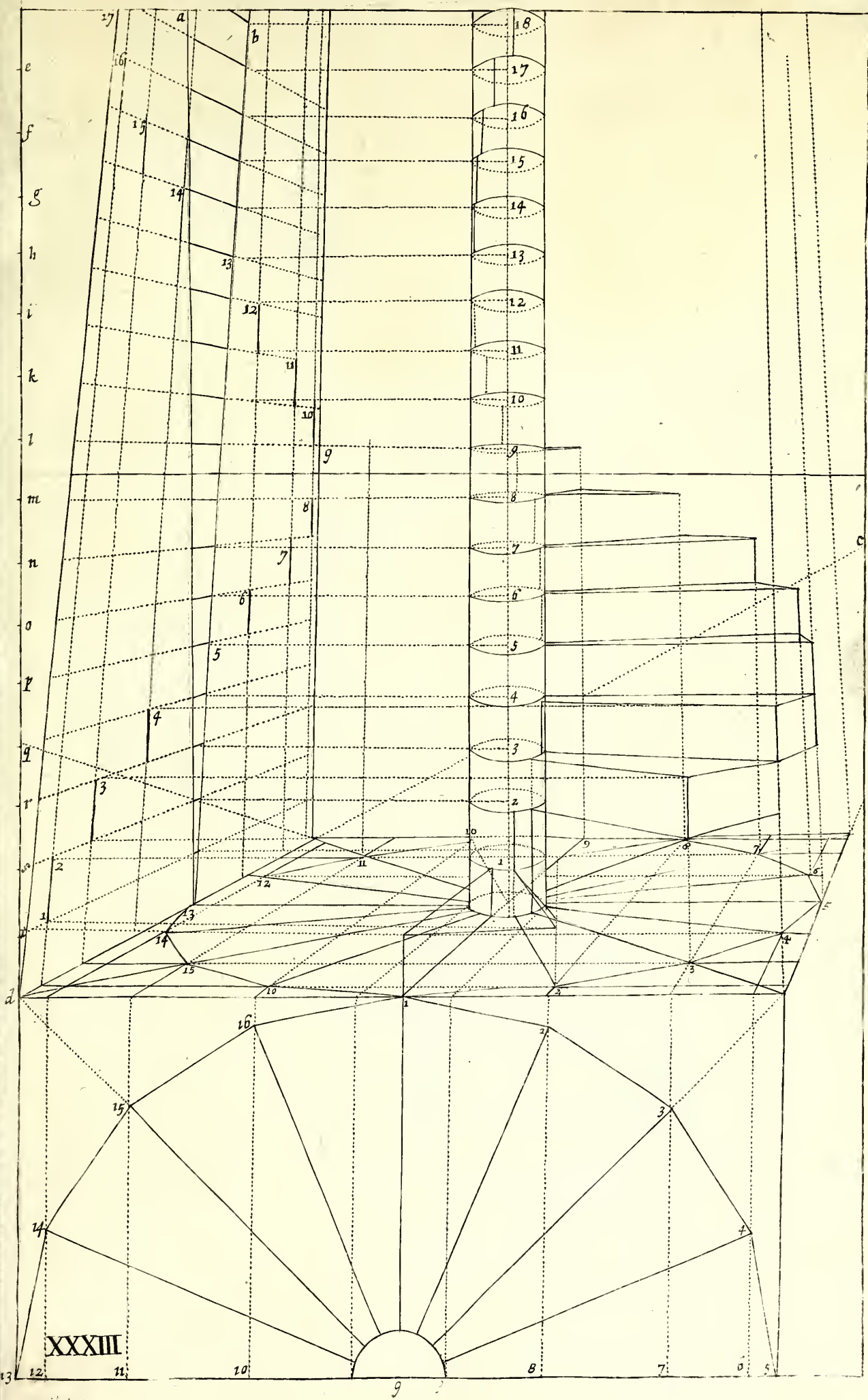






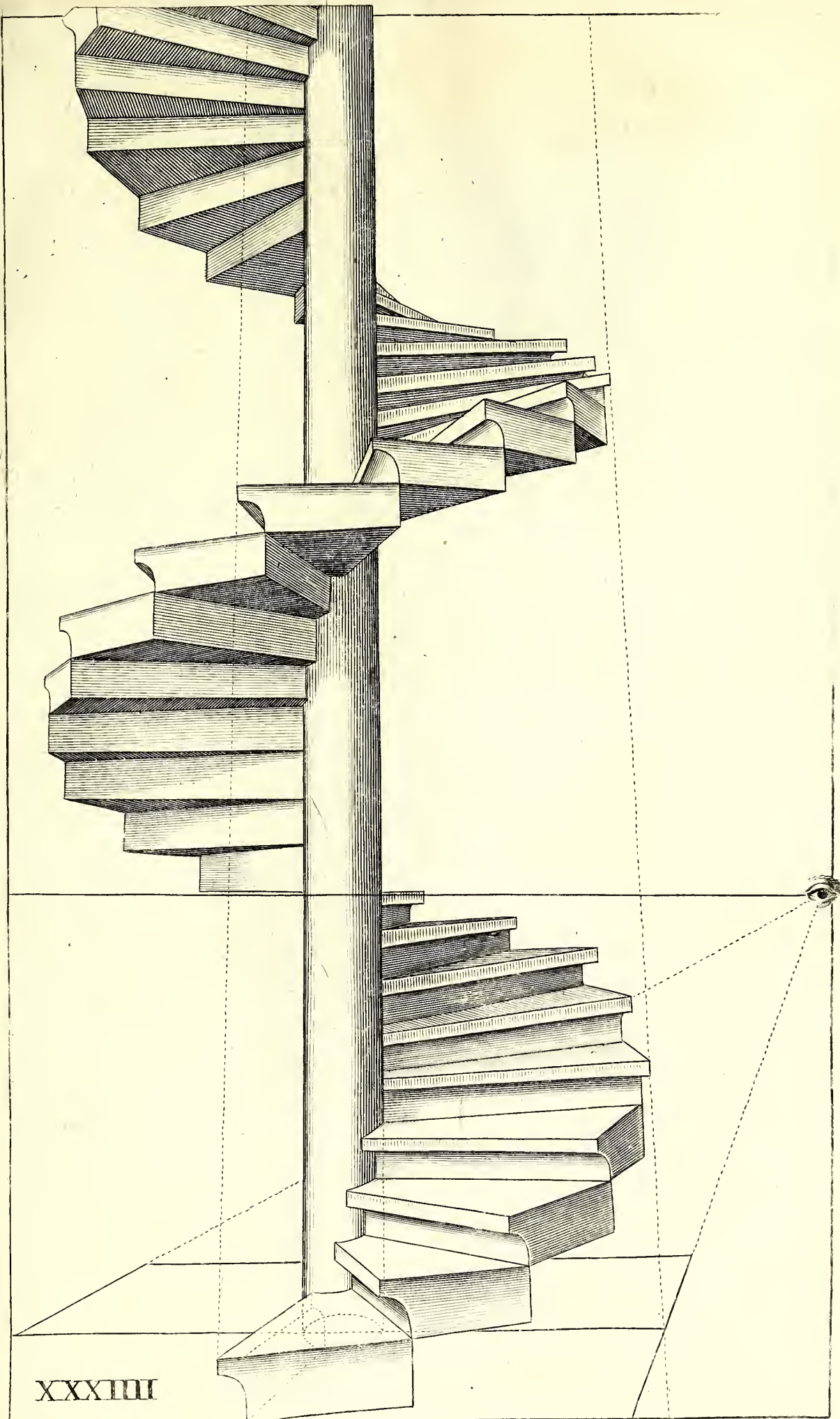
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CIA ET HIBERNIA
REX &c.



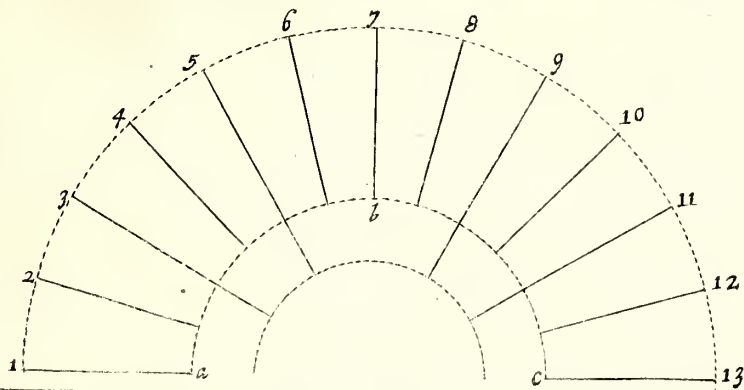
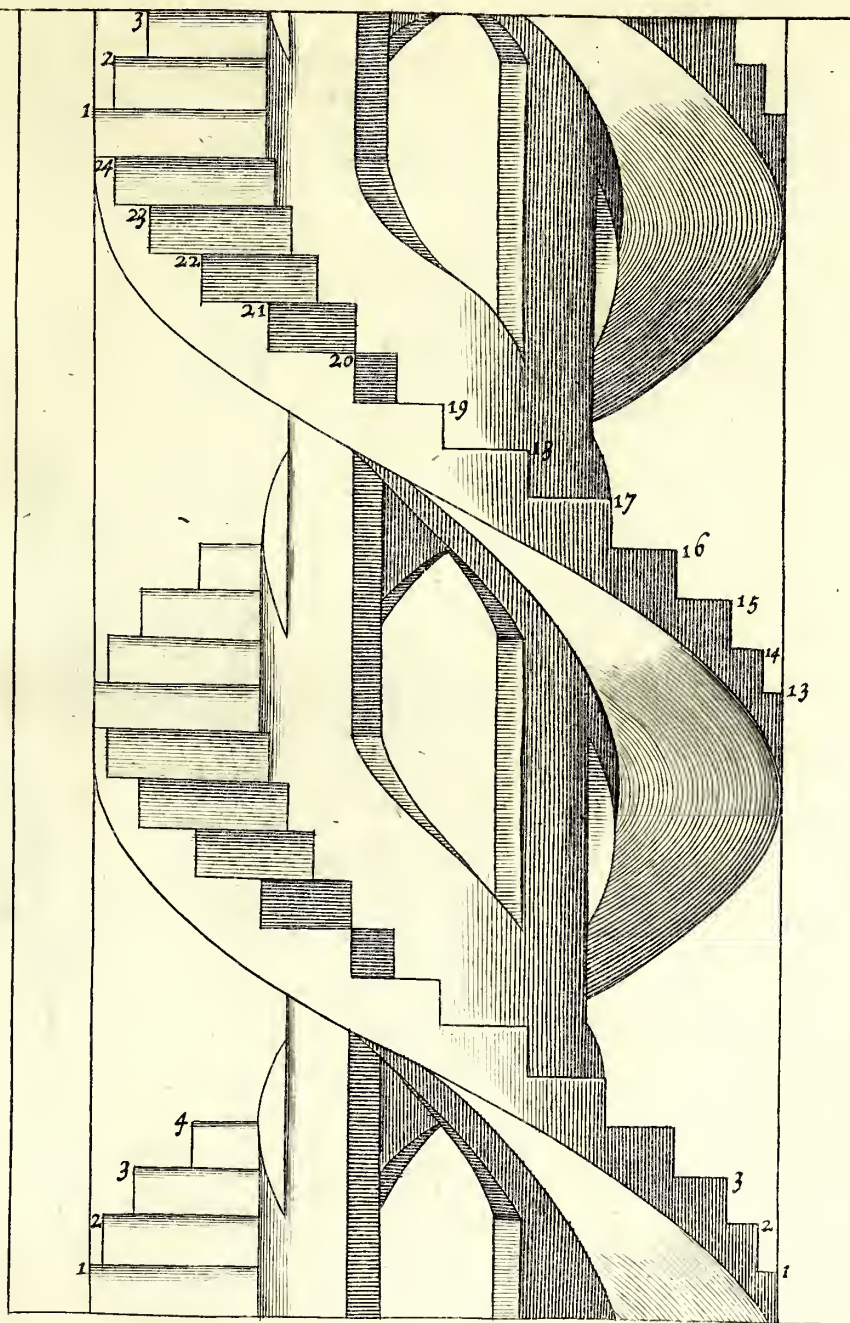


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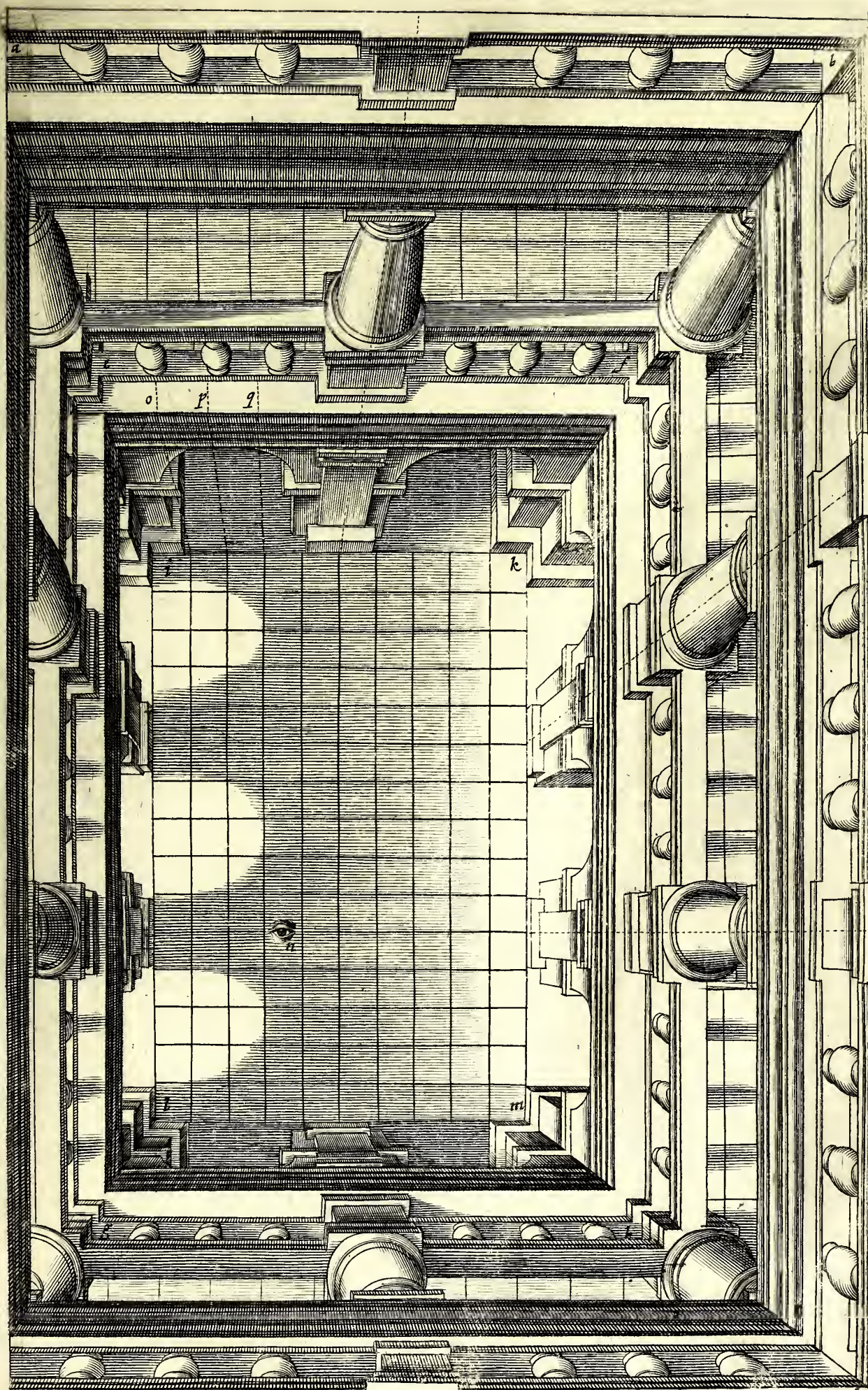


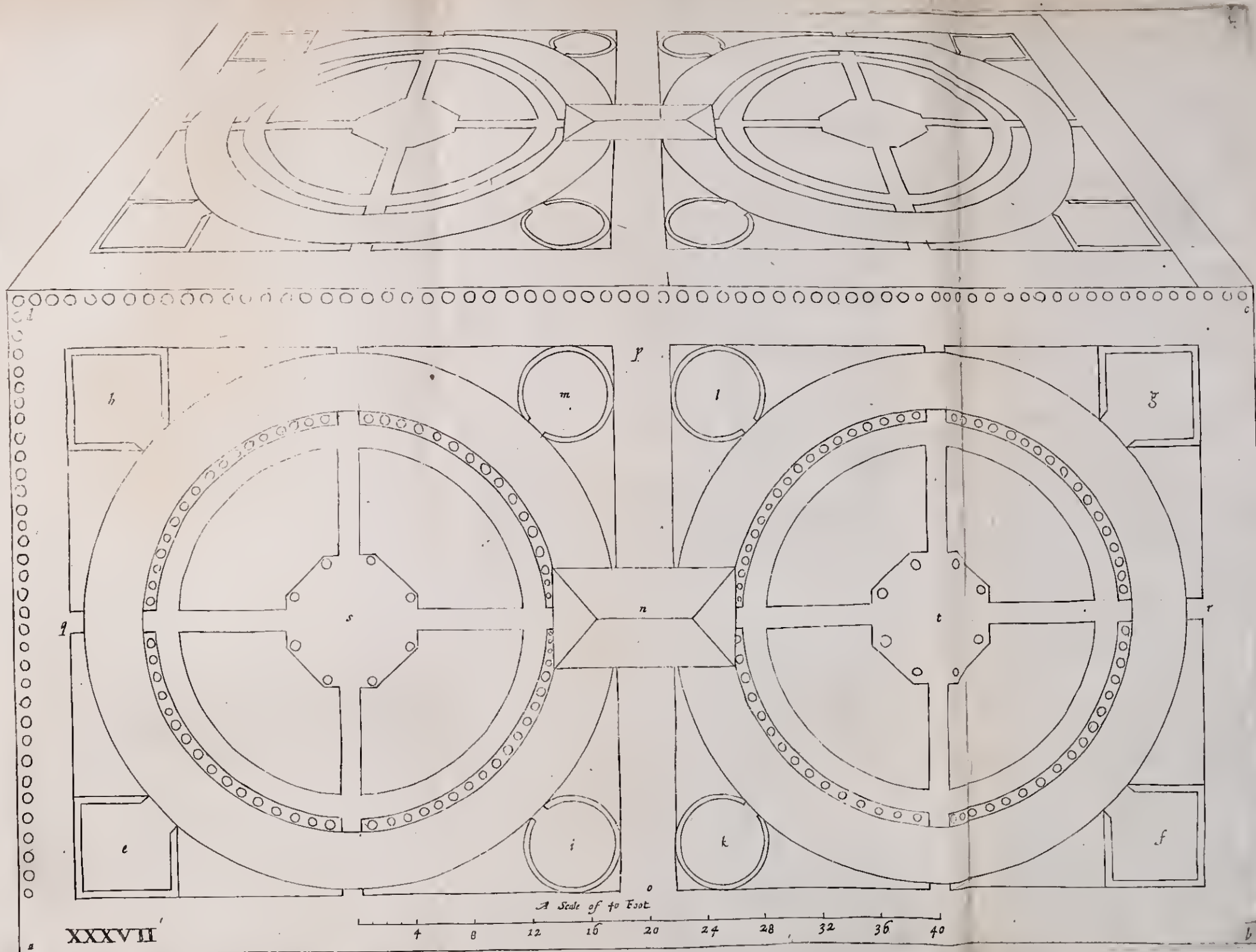


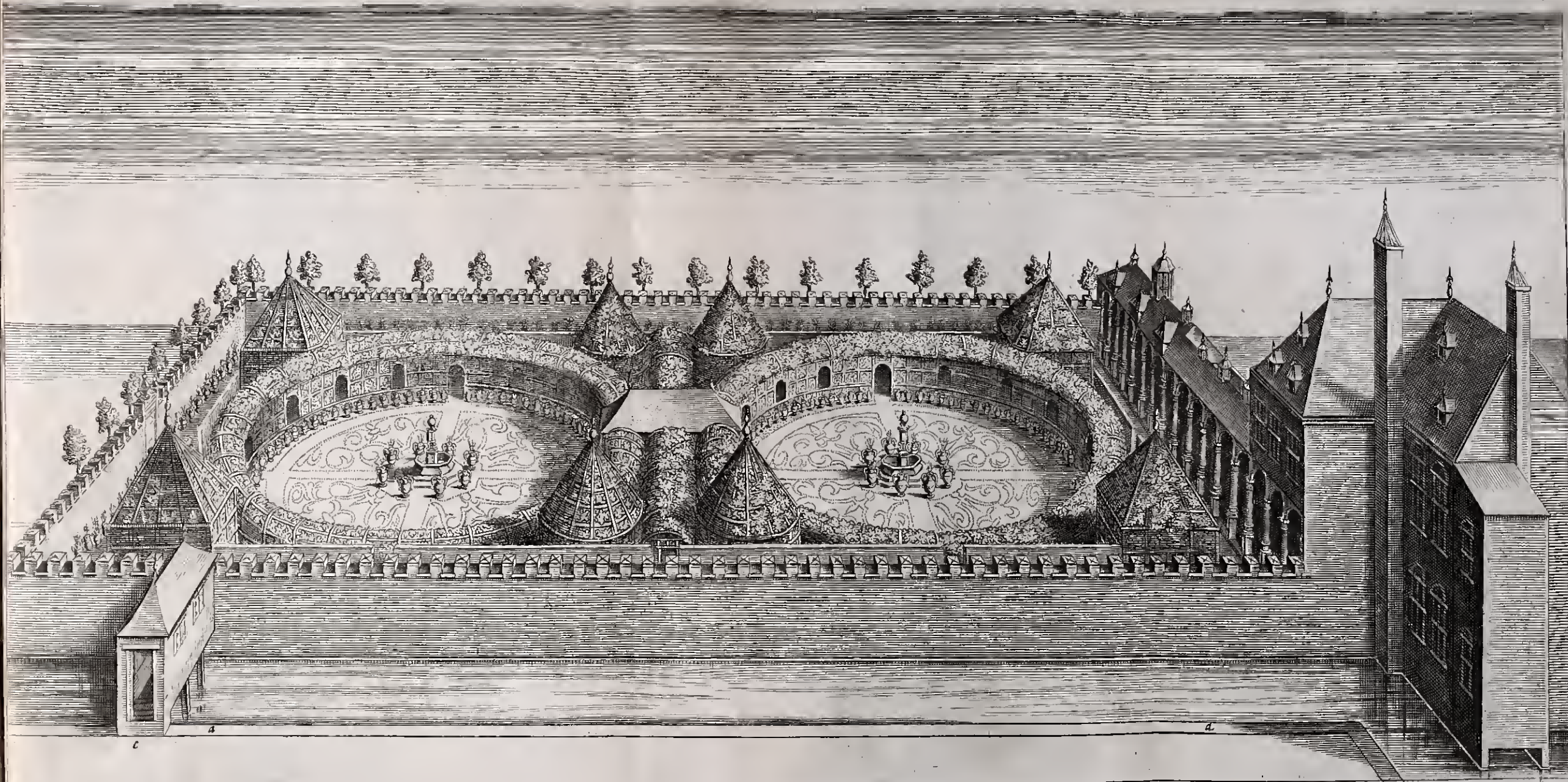
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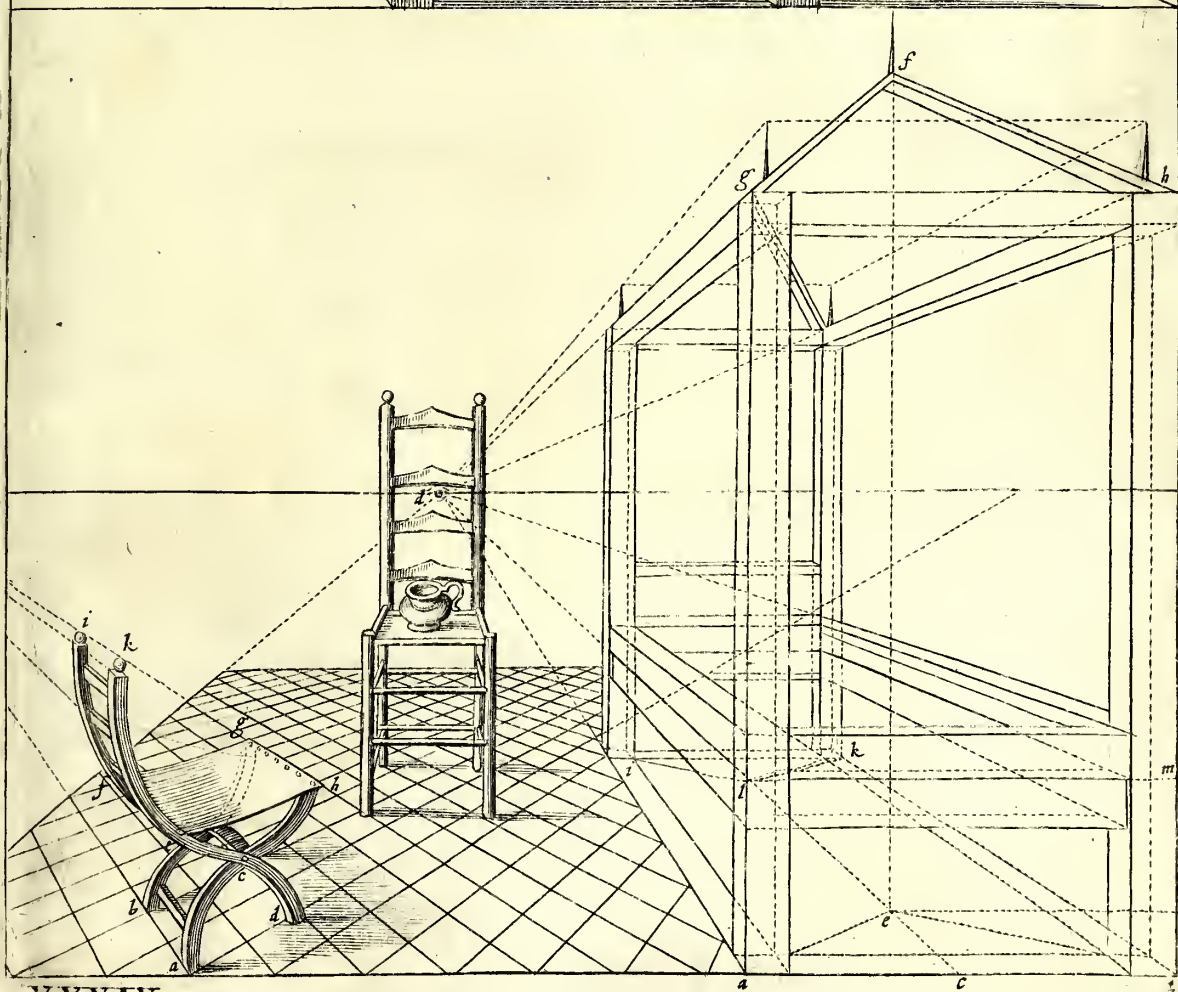
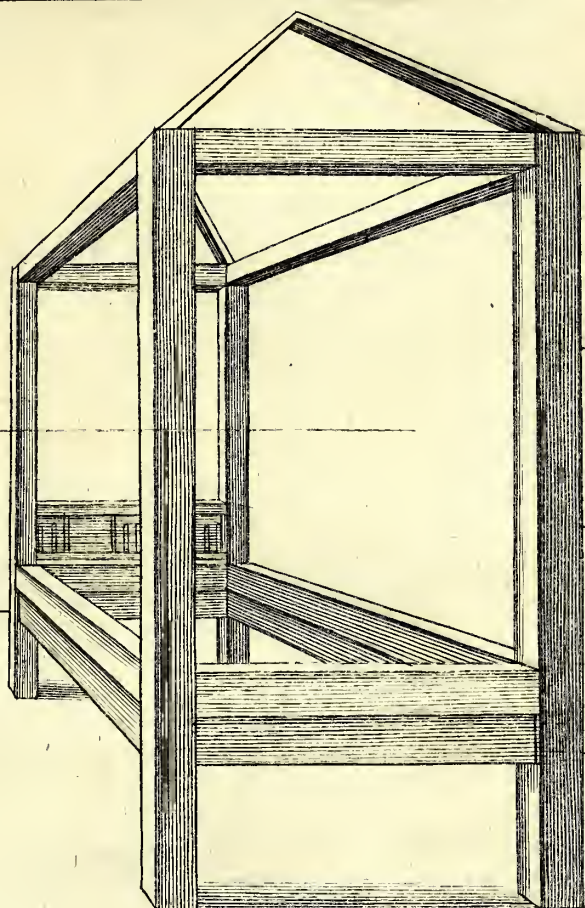


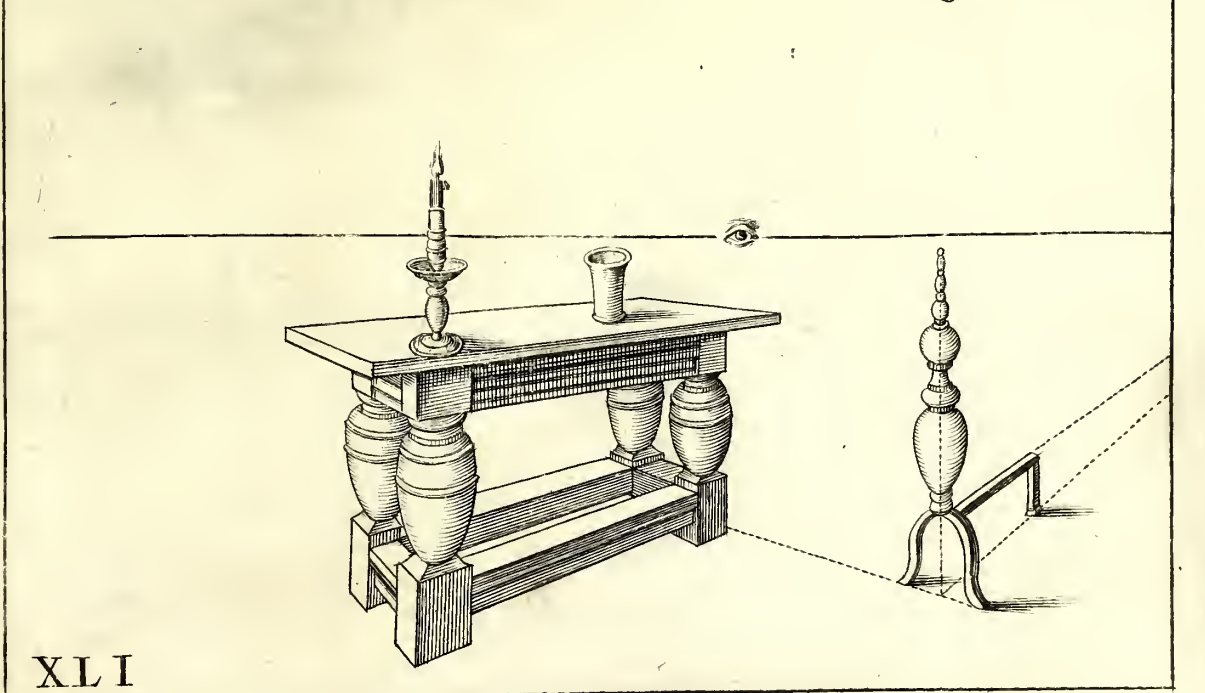
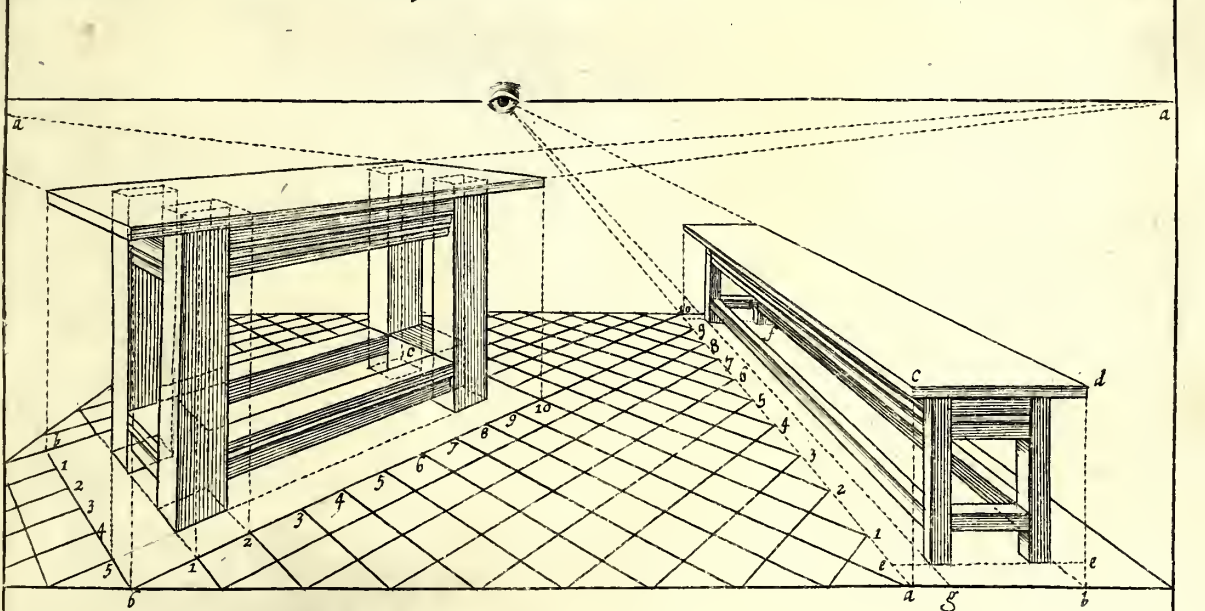
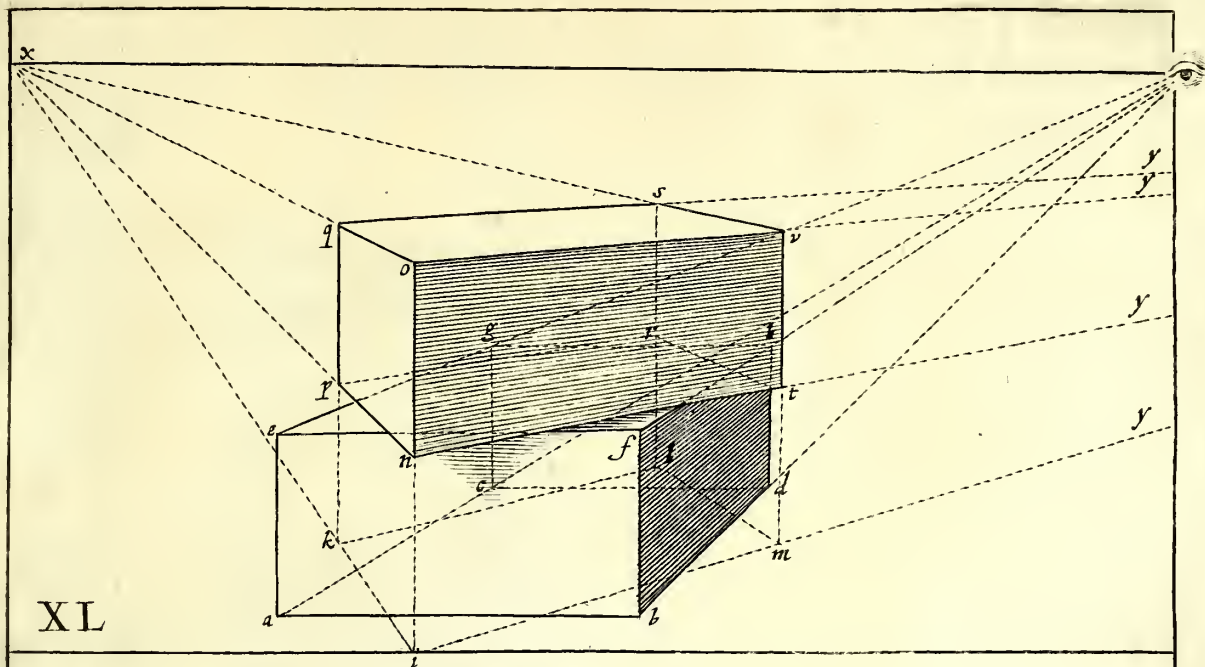


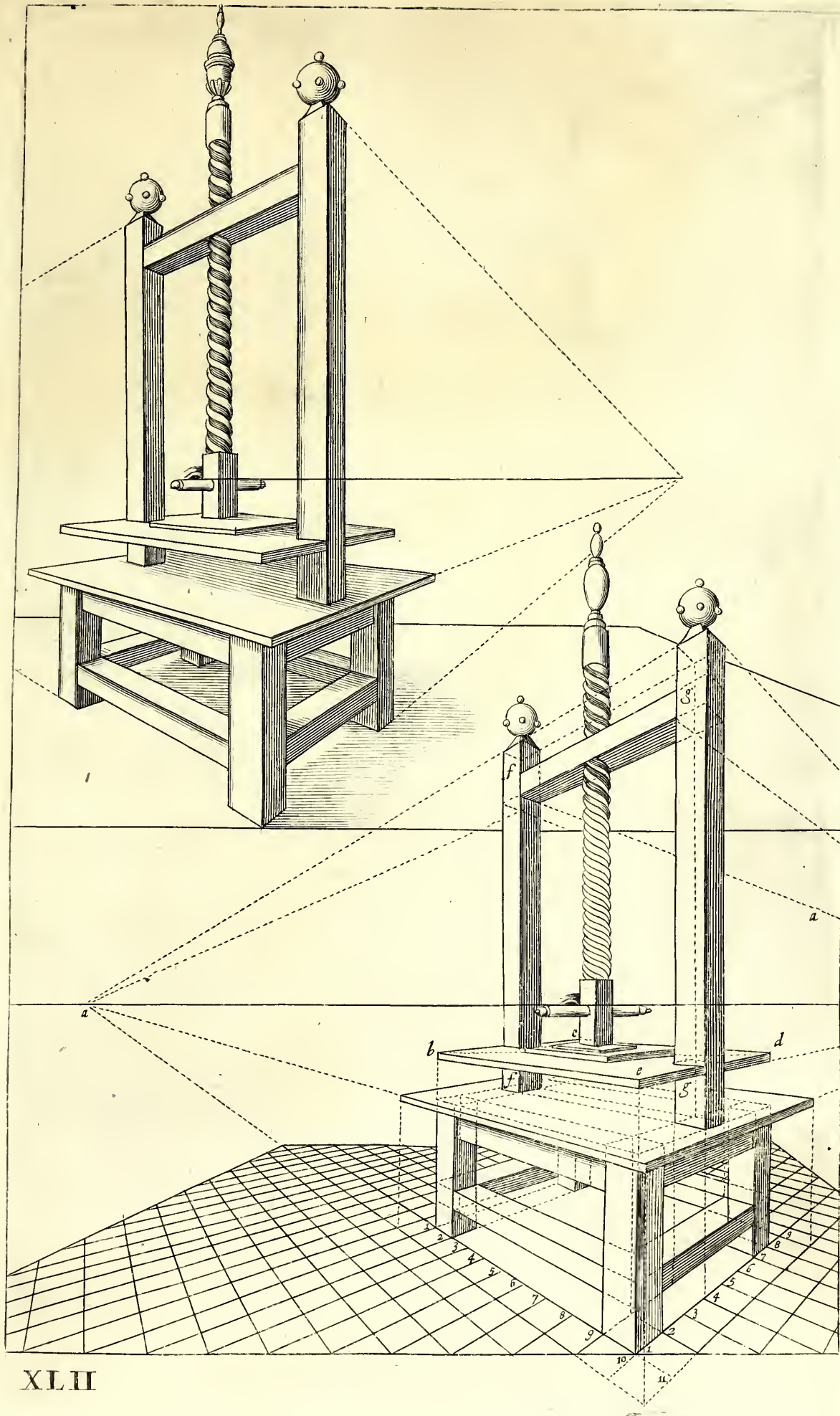


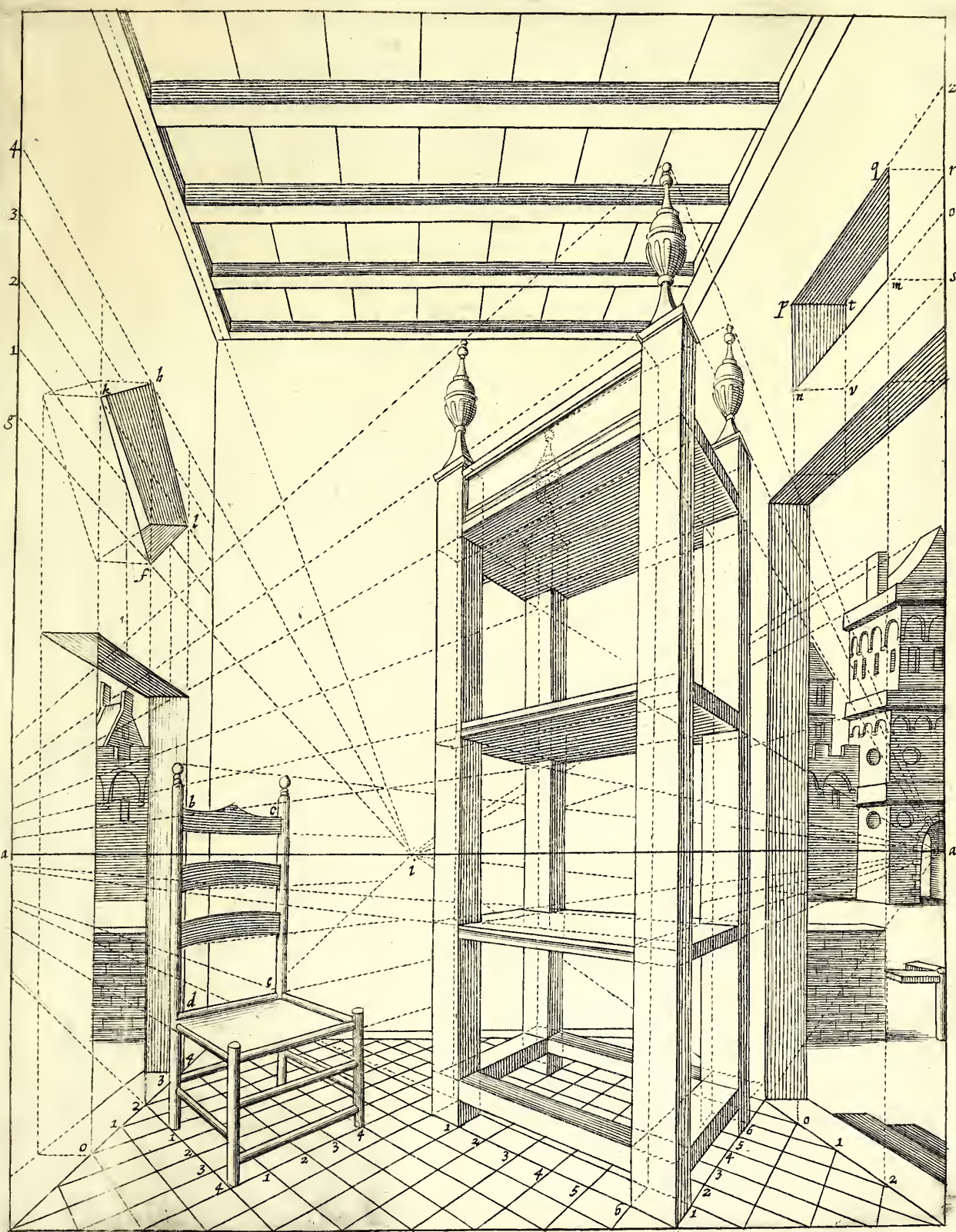


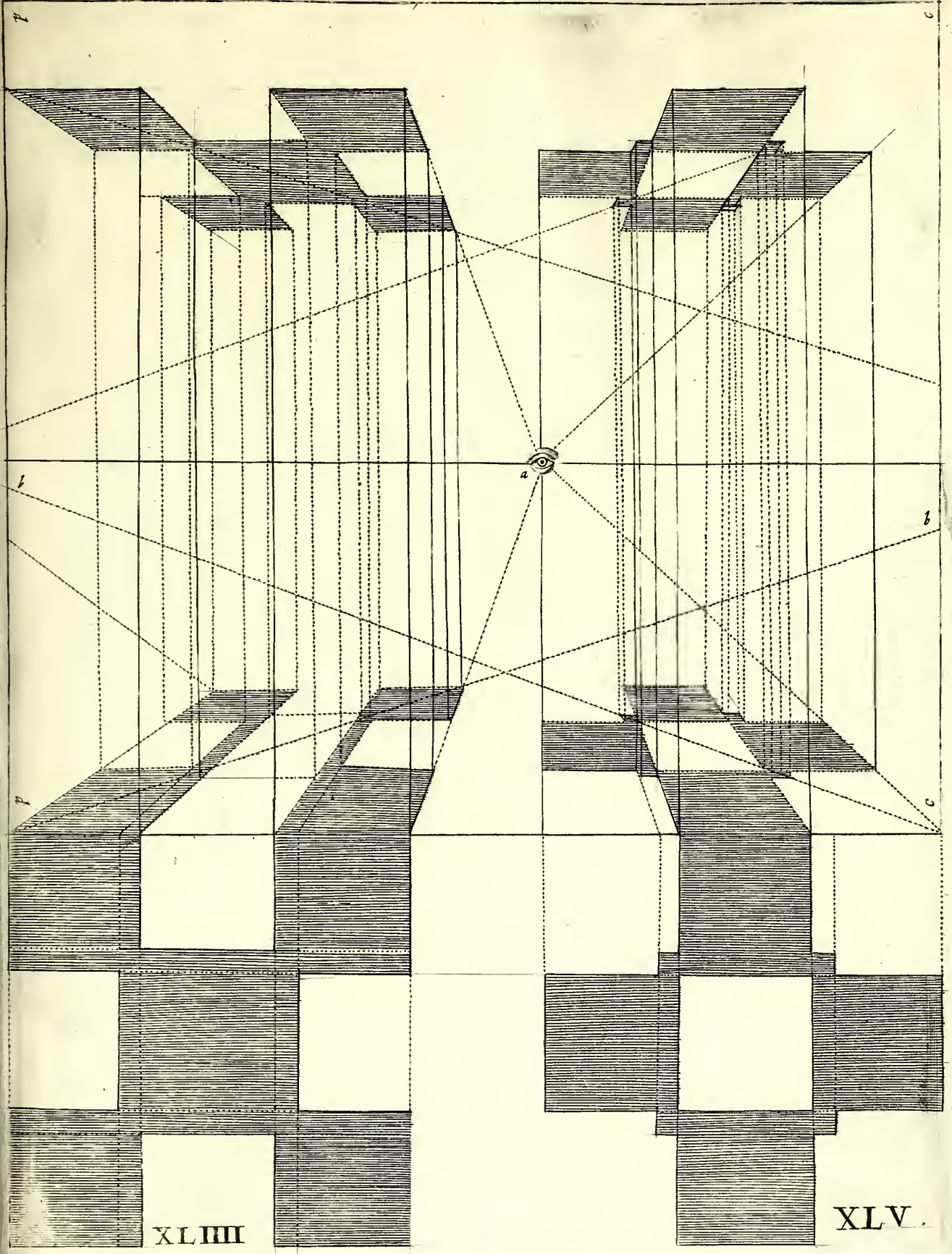








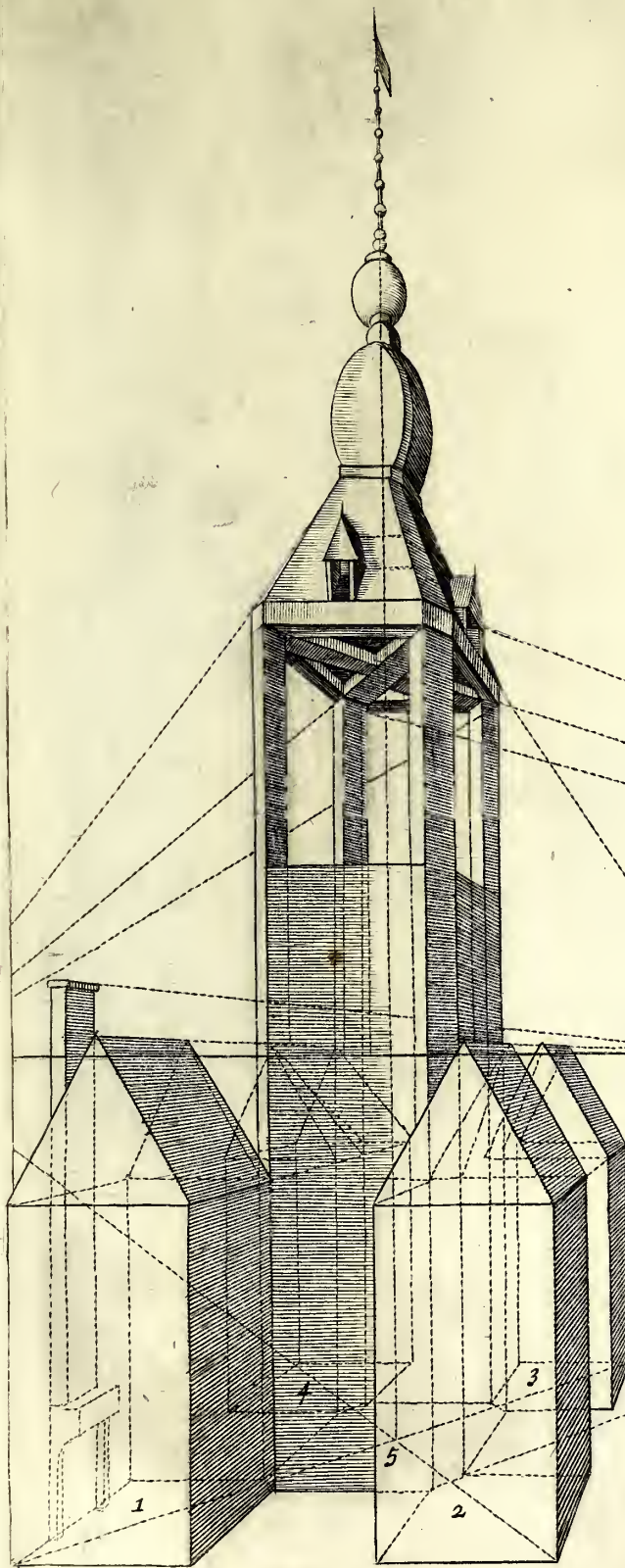




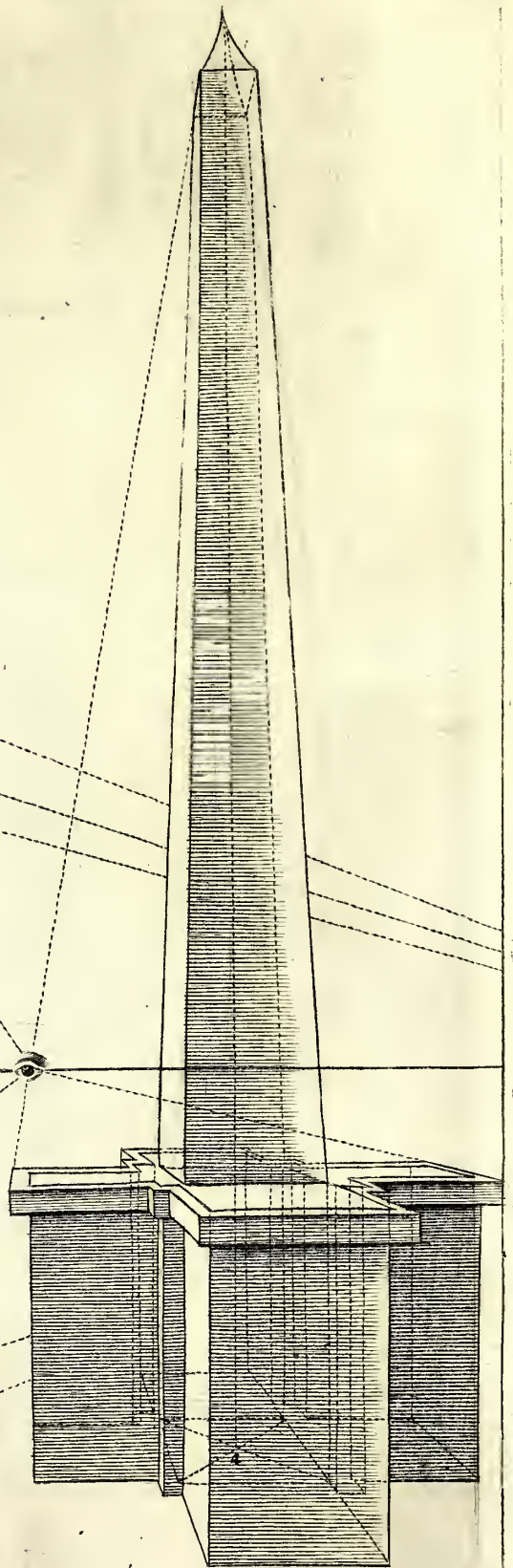
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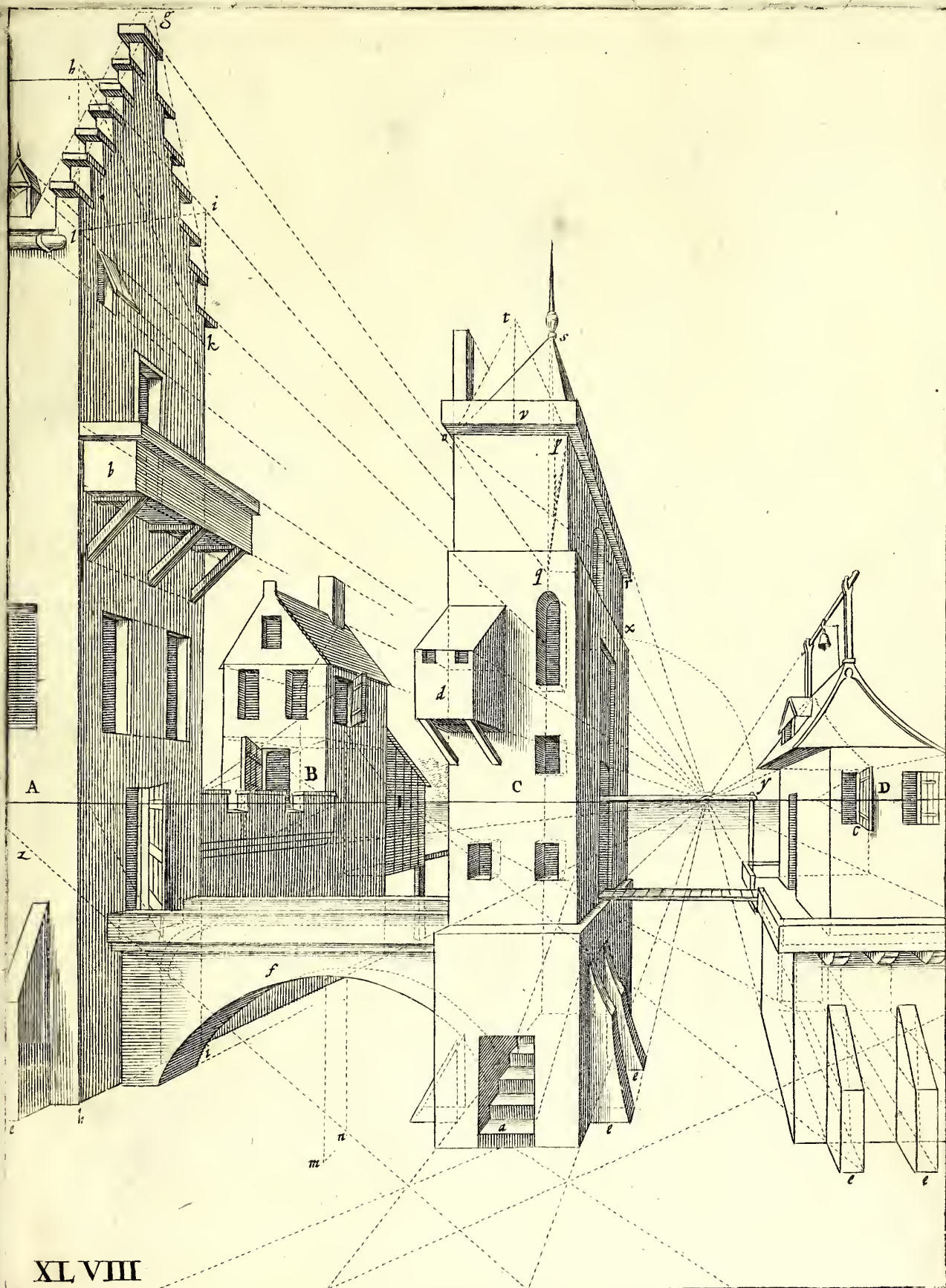


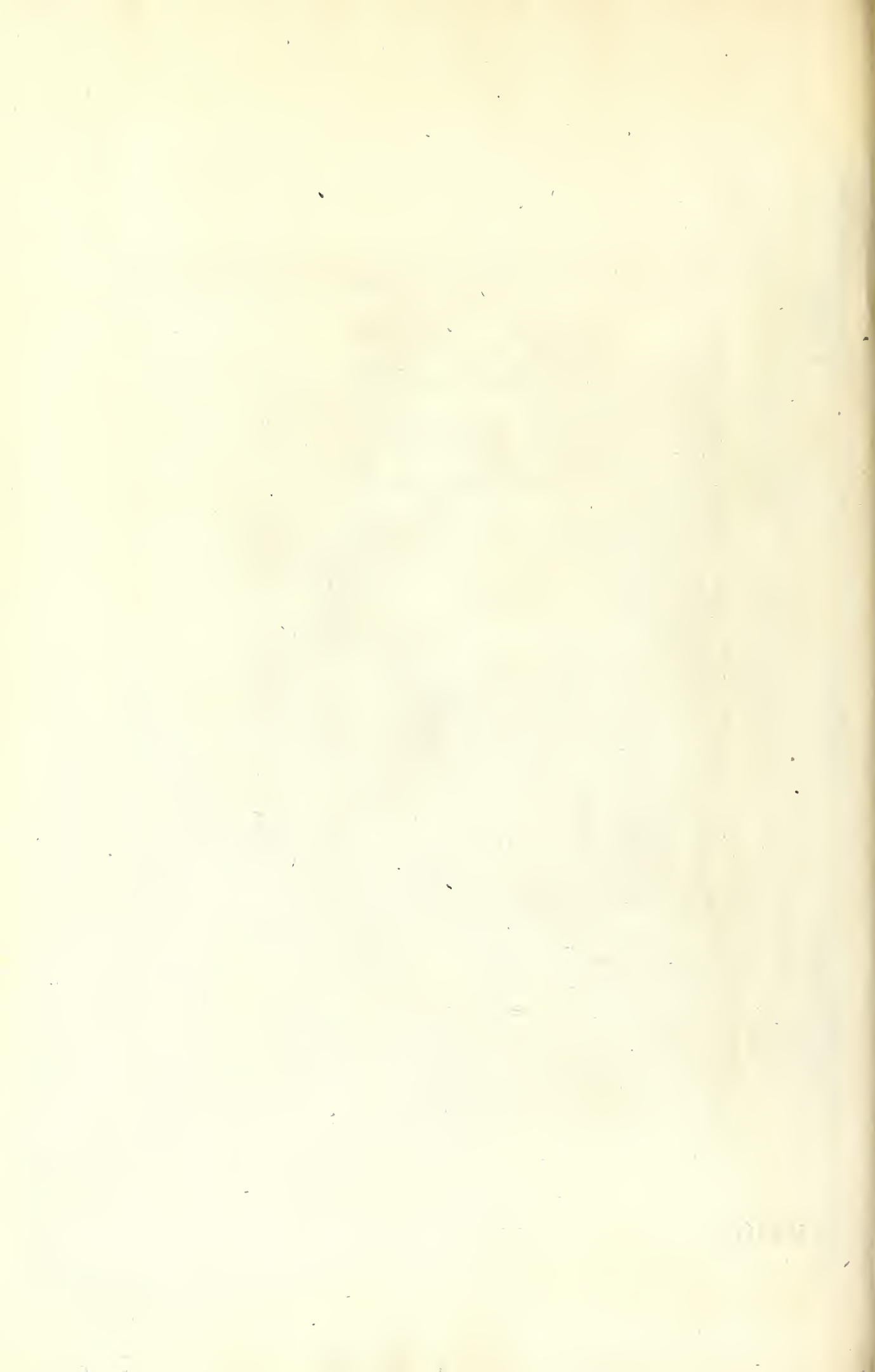


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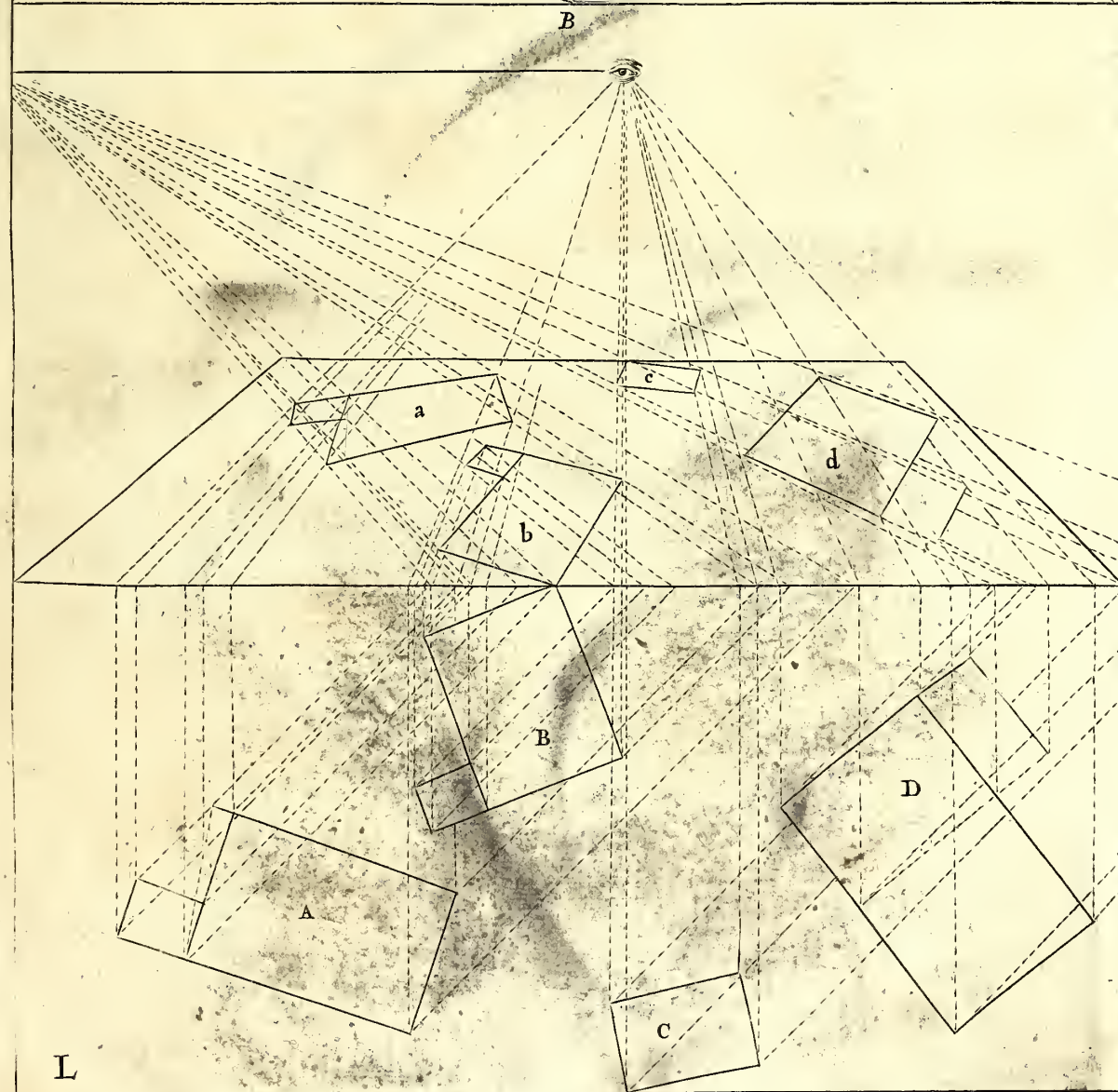
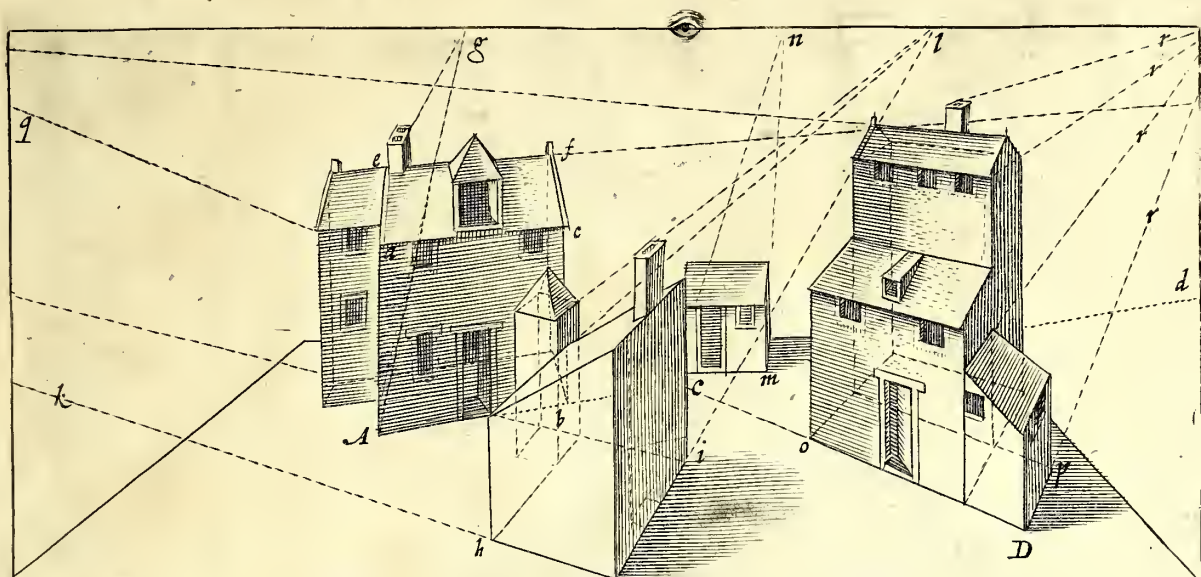


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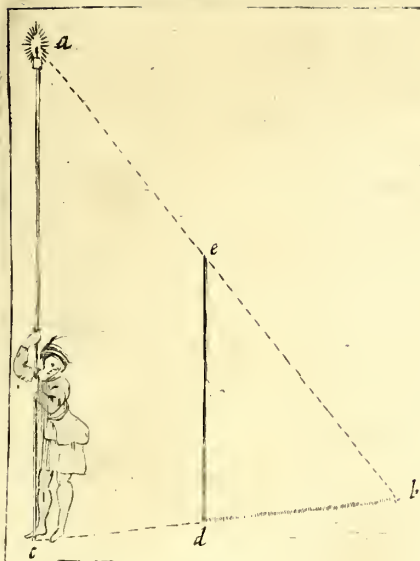




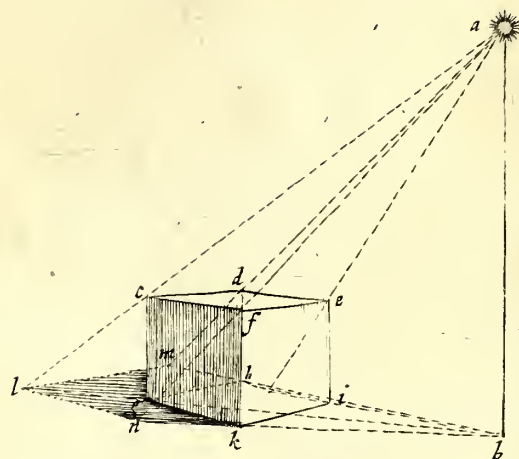




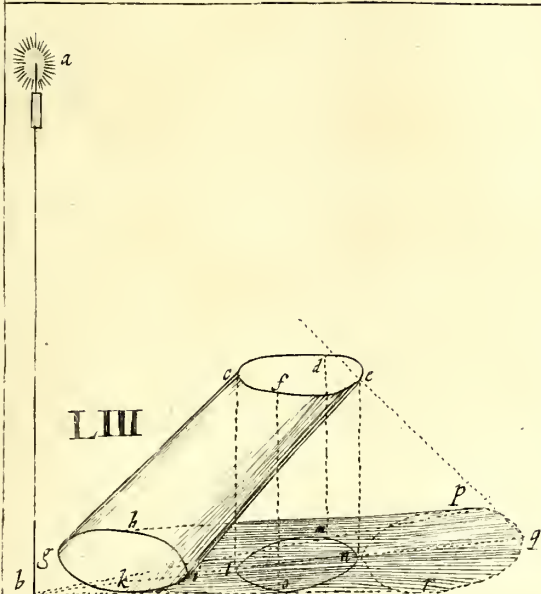




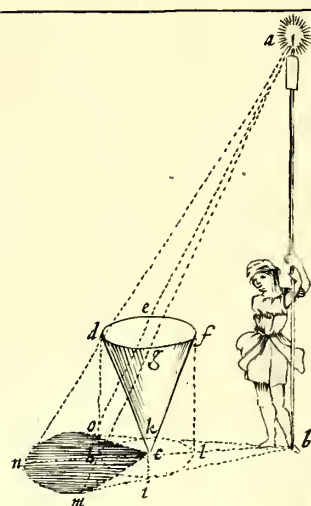
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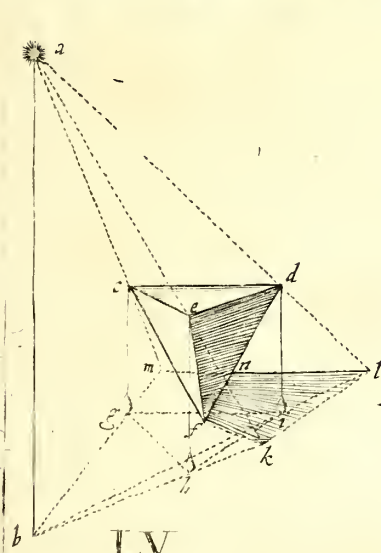
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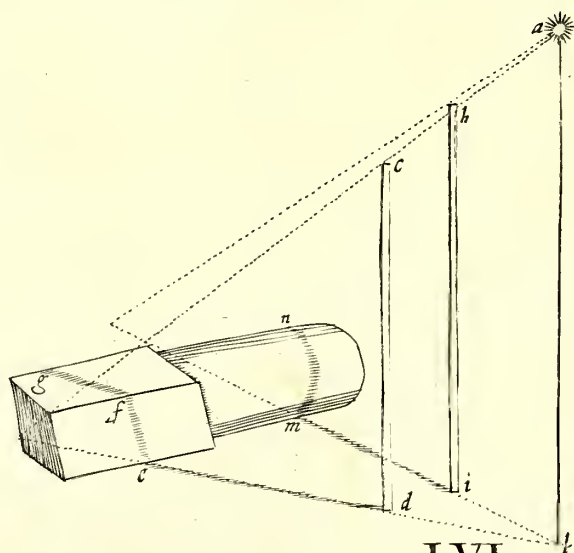
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LIII



LIV



LVI

